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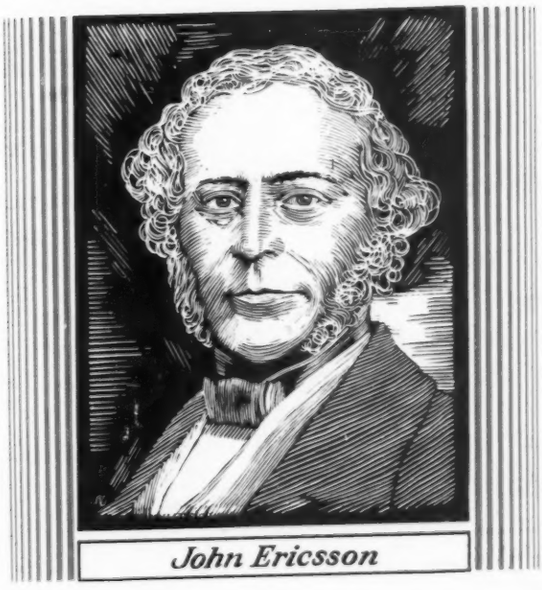
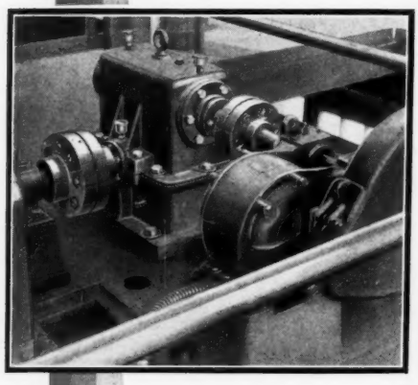
MACHINE DESIGN



John Ericsson

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES



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The INDUSTRIAL SHOCK ABSORBER

AJAX FLEXIBLE COUPLING COMPANY

Westfield New York

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Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

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SELECTION of materials has become one of the most important of the designer's jobs. And it is not an easy choice that is to be made, especially in view of the wide variety of materials available; ferrous and nonferrous; metallic and nonmetallic; and so on through the range. In order to assist the engineer in this complicated task, MACHINE DESIGN will publish with the September issue a detailed directory which will have all the materials arranged in service groups for easy selection. Characteristics, primary uses, trade names and analyses will be given.

Faith in the Future

Will Get Us Out of the Past

Henry Ford speaks his mind in an interview with James C. Derieux for Good Housekeeping magazine. Abstracted by permission of that publication.

HENRY FORD talks telegrams. Here are a few he sent to me in the course of several conversations:

"We are in trouble now because the country went into the stock-and-bond manufacturing business. People bought paper hoping to get a living without earning it. They know now they were suckers. You can't live off a printed bond and a pair of scissors."

"There is enough accumulated demand in this country right now to bring on several booms—if anybody wants any more booms."

"There never will be any saturation point until every person has everything he needs."

"So long as there are women doing heavy work about the homes, we are behind schedule in supplying the needs of this country."

"Life will be easier on all of us in a manual way, but there never can be any substitute for thinking."

"We are going to depend more and more upon our heads and less and less upon our muscles."

"I have faith in the future just as I have in the sun. Experience gives me that faith."

This and much more Mr. Ford said to me, when I asked him what was going to happen to us these next few years.

"The late 1920's were a shoddy era. Nobody thinking about making things better and selling them for less. Everybody thinking about making them as fast as possible and selling them for as much as possible. Trying in the wrong way to get out of working. Invention, improvement, science. That's the way out of work. Not speculation.

"Experienced woodsmen say that when a man is lost in the big forest, he walks round and round, getting more worried all the time. That is what a whole lot of people are doing now. You can't help sympathizing with them, but what they are doing is not going to get them out of the woods. They must have patience, must think things out, decide upon the best course and stick to it."

Use Your Experience!

"What is the best course?" I asked.

"Do whatever you can do best, the best you know how to do it. Just that. Make something better than it ever was made before and sell it for less. Do something better than it ever was done before. Use every bit of experience you have. Your problem, if you are an average man, is individual. There is not going to be any pattern for life or progress. If you wait for one, you will find yourself worse off than you now are.

"But suppose a man can't find anything at all to do, what then?"

"Well, nobody is under any obligation to starve. That's certain. If you must live off the public, I don't blame you for doing it until there is a chance for you to live off your own efforts. And the chance will come. Never doubt that. The trouble now is not with people. They want to earn and consume, and the producers want to produce. The trouble is with that thing which must pass between consumer and the producer. Money. A few years ago the people had it, but they let it get away. They will get it back.

"The money system is not working well now, and it will not work well as long as we regard money as wealth. It is no more wealth than the postage stamp is the letter. It is not money we work for, but the things we can exchange money for. Exchange is the great thing, and when money retards that, it is just too bad for money, that's all! There is a tremendous demand in this country now."

"Demand for what?"

For everything! How many of your friends have all the equipment they need for comfort? People cut down on clothing, on furniture, on household appliances, on travel, on automobiles. Old machines of all sorts are being mended and patched. That's too expensive a process to keep up. New

machines are better and cheaper. Most of the people in this country right today need to replenish almost everything. They'll do it, once the jobs and the money come back to them. They'll get the jobs and the money by persistent effort. Not by magic. Not by politics. Not by waiting around for some one else to solve their problems for them. But by the same sort of effort which has brought us along this far—individual effort.

More Machines Needed

"And there are new things needed to make life what it might be. Talk about invention having gone too far is silly. It hasn't gone far enough. These houses we live in are not modern. Noisy, dusty, badly ventilated, unevenly heated in winter, not cooled in summer. The woman of the future—not the far distant future, either, but within a few years—will find herself living in a house far more comfortable than any of today. There is no sense in the present laborious methods of housekeeping. Electricity will do the housework. Not only for the rich but for nearly every one. Millions of heating systems are antiques. And there are no home cooling systems to speak of. But all these improvements are coming, and some very quickly.

"Some people have suggested, Mr. Ford, that because of our present troubles we shall go back to former ways of doing things. Seemingly you do not agree with them."

"Of course, not! This talk about going back is foolish. Back to what? The old-time wood-burning cook stove? To roads deep in mud? To the oil lamp? To the horse and buggy? Yes, I have heard people talk about going back, but they never say what we are going back to."

"Maybe to thrift," I suggested.

"That's out of date, if you mean thrift in the old sense. The idea is not to cut down expenses to the barest necessities, but to increase income. This can be done by freeing ourselves from laborious processes, and thus giving more time for higher forms of work. A lot of people seem to forget that this situation we are in now is temporary.

"And when shall we get started again?"

"We already have started," he said. "I think recovery began in October, 1929, when we came to the end of that immoral business era which we misnamed 'prosperity.' It was like calling the flush of fever the glow of health. Everything today has to be much better than it was then, and lower in price, or it will not sell. People are better buyers than they were then. That looks good to me. When we are improving the product and cutting the price at the same time we are getting somewhere. This is the process of recovery, of advancement. It hasn't gone far enough yet to provide enough work. But if each one keeps on trying hard, we'll soon be there."

"And meanwhile?"

"Think. Think and try hard to do something. Even with all the suffering today people are not thinking enough."

"Some think we have freed them of their jobs while freeing them from laborious ways of doing things."

"Nonsense! The machine is not at fault. The machine has created more jobs. There are more men on the sea under steam than ever were on the sea under sail. The automobile gives employment in factory and garage far beyond anything the horse and wagon could give in wagon shops and blacksmith shops. The machine may have been mismanaged in some respects, but don't blame the machine for that. It is man's friend.

LEADERS such as Henry Ford, Charles F. Kettering, William B. Stout and others have expounded on the relation of the technical to the human aspect of the machine at various times during recent years. Their views have become somewhat of a philosophy . . . a stimulus to a languid world. Kettering by his common-sense suggestions has taken much of the mystery out of engineering research. Stout predicted the basis of our present automotive trends. Ford, with his homely attitude and love for the pristine, has encouraged the design and development of even more machines to relieve mankind of the drudgery of some types of work. In the accompanying abstract he succeeds again in arousing new hope with his iron-clad faith in the future. The article bears testimony to the fact that engineers, particularly designers, no longer are supplementary to industry—their work is the foundation upon which industry is built.

"This talk about a return to hand labor leading to employment is rot. Suppose the automobile had to be made by hand. Each one would cost so much that only the rich could buy. This would mean a thousand cars where now there are a million, and that would mean ten men employed where now there are ten thousand. How would the housekeeper like to go back to oil lamps or to candles or to lighted pitch knots? What good would that do? Does any one think more people could be employed in making candles than in the electrical industry? Does any one wish to go back to muddy roads?"

"You said something about going back to the land?"

"Yes. By that I mean the crowded cities will begin to break up. Cities are out of date. They grew up in the days when transportation and communication were slow and hard, when for protection of one sort or another, for conveniences in the home, and for purposes of trade people had to jam themselves together. This started the process of city growth. Because people already were in the cities, manufacturers came knowing they would find labor, and because manufacturers came, more labor arrived. We must reverse that process. Cities are wasteful, costly.

"The thrift of the future is not penny saving, but time saving. The pioneer woman did not have much time-saving equipment. The kitchen of a few years ago had only a few things in it and required most of a woman's time. The kitchen of today has much in it, and leaves the housewife with time for other things. And, of course, the use of leisure, is a severe test of character. But in these days everybody has more time for everything—thanks to the machine shop and home. This is progress.

Urges Confidence, Imagination

"We know a few things about the human make-up. One is that lack of confidence, fear, hinders us. Another is that a man must imagine himself as doing a thing before he can do it. Now, if we must think of ourselves at some distant time, why not make the picture in our mind as we would like it? These are the things that come true. This can't do us any harm, and it is certain to help. Many will go through, and are going through, hard experiences—in fact, not one person can escape—but they will come out. The human race is not going to fail. We are enduring many hard things today in order that our children may not have to endure those same things. If I did not believe that, I could not believe much of anything. We are going ahead."

"Without any specific plan?"

"Without any specific plan aside from the greatest of all plans, which life unfolds in events, and under which each one of us is always free to do the best he can."

CALENDAR OF MEETINGS AND EXPOSITIONS

Aug. 12-20—Economic Conference of Engineers. Sponsored by Stevens Institute of Technology and to be held as a camp near Johnsonburg, N. J. Information may be obtained from the Institute at Hoboken, N. J.

Aug. 23-26—National Oil and Gas Power Meeting. Annual meeting sponsored by American Society of Mechanical Engineers will be held at Ritz-Carlton hotel, Atlantic City, N. J. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the mechanical engineering society.

Aug. 23-26—Silver Bay Industrial conference. Sixteenth annual conference on industrial relations at Silver Bay on Lake George, N. Y. E. C. Worman, 347 Madison avenue, New York, is secretary of the conference.

Aug. 27-31—Leipzig Trade Fair. Fall fair to be held at Leipzig, Germany. Information may be obtained from Leipzig Trade Fair Inc., 10 East Fortieth street, New York.

Aug. 28-Sept. 2—National Association of Power Engineers. Exposition of equipment and accessories and annual meeting to be held at Hotel Statler, Buffalo. Fred W. Raven, 1140 Lake street, Oak Park, Ill., is secretary of the association.

Aug. 28-Sept. 4—International Automotive Engineering congress. This meeting sponsored by Society of Automotive Engineers and to be held at Palmer House, Chicago, will include papers on "Current Practice in Finishing Gear Teeth," by F. W. Cederleaf; "The Engineer's Place in the Economic Picture," by C. F. Kettering; and "What Is the Matter with American Cars?" by L. H. Pomeroy. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary of the automotive engineering society.

Sept. 7-9—Electrochemical society. To meet in Chicago. Colin G. Fink, Columbia university, New York, is secretary of the society.

Sept. 7-23—Twelfth Shipping, Engineering and Machinery Exhibition. To be held at Olympia, London, England. Information may be obtained from F. W. Bridges & Sons Ltd., Grand Buildings, Trafalgar Square, London, W. C. 2, England.

Sept. 22-30—Electrical and Radio Exposition. Post-depression show under the auspices of Electrical Association of New York to be held at Madison Square Garden, New York.

Sept. 23-Oct. 1—Second American Exposition of Brewing Machinery, Materials and Products. To be held at Auditorium hotel, Chicago. Felix Mendelsohn, Auditorium hotel, Chicago, is managing director of the exhibit.

Sept. 26-28—Technical Association of the Pulp and Paper Industry. Fall meeting is to be held at Appleton, Wis. R. G. Macdonald, 370 Lexington avenue, New York, is secretary of the association.

Oct. 2-6—National Safety council. Annual meeting at Chicago. W. H. Cameron, 20 North Wacker drive, Chicago, is managing director of the council.

Oct. 2-6—National Metal Congress. Annual exposition to be held at Detroit. Information may be obtained from W. H. Eisenman, 7016 Euclid avenue, Cleveland.

Oct. 2-6—American Welding society. Annual fall meeting at Book-Cadillac hotel, Detroit. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary of the society.

Oct. 2-6—American Society for Steel Treating. Annual exposition and technical meeting to be held at Detroit. W. H. Eisenman, 7016 Euclid avenue, Cleveland, is secretary of the society.

Oct. 2-6—American Institute of Mining and Metallurgical Engineers. Annual meeting of the Iron and Steel and Institute of Metals divisions to be held at Detroit. A. B. Parsons, 29 West Thirty-ninth street, New York, is secretary of the institute.

Oct. 16-19—National Business Show. Exposition of business machines and similar equipment to be held at New York. Information may be obtained from E. Tupper, 50 Church street, New York.

Oct. 17-19—Association of Iron and Steel Electrical Engineers. Mechanical, combustion, lubrication, electrical and safety division meetings, twenty-ninth annual convention and iron and steel exposition to be held at Wm. Penn hotel, Pittsburgh. John F. Kelly, 1010 Empire building, Pittsburgh, is managing director of the association.

Oct. 23-28—Motor and Equipment Manufacturers' association. Annual exposition to be held at Merchandise Mart, Chicago. C. C. Secrist, 5750 Roosevelt road, Chicago, is secretary of the association.

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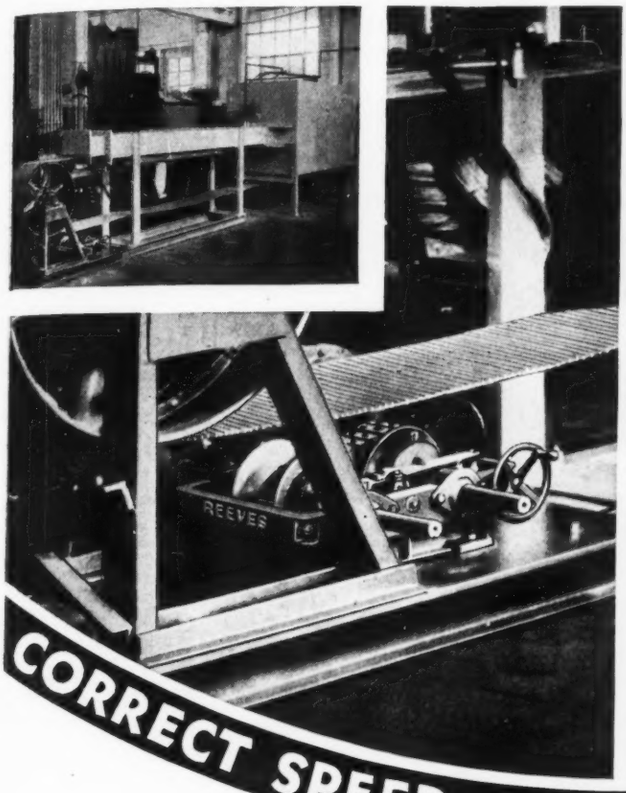

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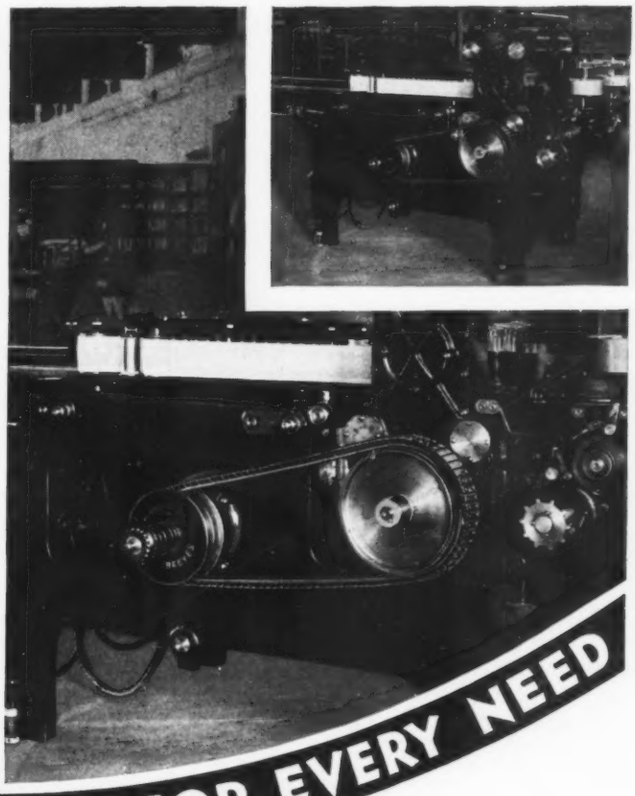

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MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

August, 1933 Vol. 5—No. 8

Value of Patent Depends upon Efficient Claims

By George V. Woodling

THERE are two major phases that should be investigated when analyzing the patent situation in relation to a new invention: The question of infringement of adversely-held patents; and the question of securing patent protection upon the novel features of the so-called improvement invention in order to prevent others from copying the design.

The question of infringement will be considered first. A patent gives the patentee title to an intangible right, in the nature of a privilege or a franchise. An unauthorized interference with this intangible right during the life of the patent constitutes an act of infringement. Hence, before one can determine whether or not certain unauthorized acts constitute an infringement it is necessary to ascertain the scope or the extent of the intangible right granted to each patentee in all of the many adversely-held patents.

To determine this scope, one must understand the purpose of, and the legal significance imposed upon, the parts of a patent. Exclusive of the "granting" clause, a patent, that is

Copyright, 1933, *George V. Woodling*

I Claim—

1. The combination with a road-locomotive, provided with suitable running gear including a propelling wheel and steering mechanism, of a liquid hydrocarbon gas-engine of the compression type, comprising one or more power cylinders, a suitable liquid-fuel receptacle, a power shaft connected with and arranged to run faster than the propelling wheel, an intermediate clutch or disconnecting device and a suitable carriage body adapted to the conveyance of persons or goods, substantially as described.

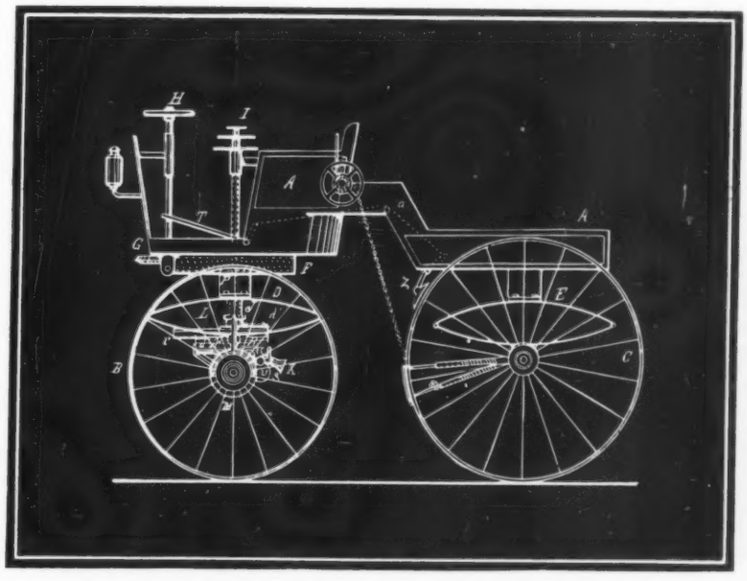


Fig. 1—The claim, shown above the illustration, of the famous Selden patent was drawn in 1895 with such skill that it still "reads on" every make of automobile. The patent has now expired

the instrument by which the intangible right is evidenced, comprises three parts: the drawings, the specification, and the claims. The drawings must show every feature of the invention covered by the claims. The specification is a description of the invention and of the manner and process of making, constructing, compounding and using it. The claim is statutory requirement for the purpose of making the patentee *define precisely what his invention is.*

The scope of the intangible right of a patent is not defined or measured by the drawings or the description of the invention, but by the claims interpreted in the light of the drawings, the description and the prior art. Thus, it is the claims and the claims only that constitute a fence around the thing patented and which protects it from trespassers. All that which is not enclosed by the fence of claims is public property.

An inventor may produce a thousand acre invention, but if in drafting the patent claims the attorney includes only one hundred acres of the invention, that is all his patent covers. Unless corrected by taking out a reissue patent within the time prescribed by patent laws, subject, however, to the intervening rights of other inventors, the remaining portion is dedicated to the public.

Let us consider as a typical example a knife invented by A, Fig. 3*A*, which, we will say is the first knife and is protected by a patent having the following claims:

> 1. A knife comprising a handle and a blade having a cutting edge, the handle and the blade being formed of one integral piece.
>
> 2. A knife comprising a handle and a blade having a cutting edge.

These two claims and these two claims only define A's rights. The scope of the intangible right defined by claim 1 may be represented by the area fenced in by circle A_1, Fig. 4, and the scope of the intangible right defined by claim 2 may be represented by the area in circle A_2. The area enclosed by circle A_1 is less than that by circle A_2, because the scope of the intangible right defined by claim 1 is restricted or limited by the provision of the claim which states that *"the handle and the blade are formed of one integral piece—."* In other words, the more restrictions or qualifying phrases that a claim contains, the smaller or narrower its scope. Accordingly, claim 1 generally is referred to as a specific or narrow claim, and claim 2 as a broad claim.

Assume that C, inventor of the knife shown in Fig. 3*C*, desires to manufacture and sell his product. Feeling confident that there is no knife on the market like his, C decides to market his knife without first investigating the question of infringement of adversely-held patents. He may know about A's and B's knives but he believes that, since his knife is so different from A's, there cannot possibly be any question of infringement of A's patent. By the same reasoning, he believes that since his knife constitutes a vast improvement over B's, Fig. 3*B*, there is no infringement of B's patent for the reason that in B's knife the blades are free to move from one position to another without restraint, whereas in his the coacting springs resiliently hold the blades in their respective positions—the one feature that gives it commercial merit. Thinking that his knife is free of infringement, C starts to manufacture and sell it. Much to his surprise he receives a letter from A charging him of infringement of A's patent and requesting him to desist from further infringement and account for past infringement.

If A's charge is correct and can be sustained, C will have to pay tribute to A by way of royalties, or be enjoined from further manufacture

I Claim— 4. In the transport of bodies by aeroplane, the method of controlling the propeller thrust and reaction of the planes by varying the power of the motor correspondingly with the inclination of the machine so as to maintain the lifting force sensibly constant during the forward flight.

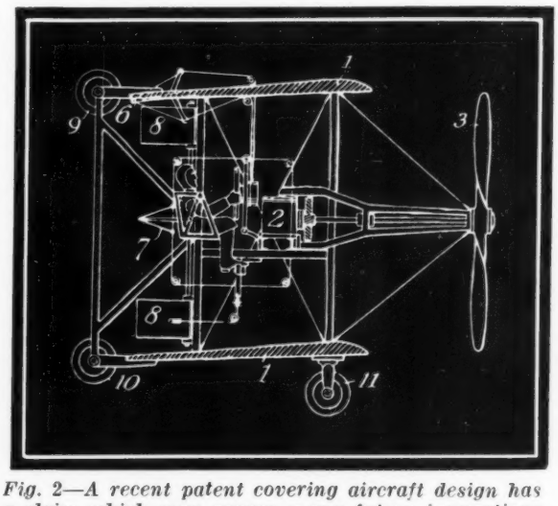


Fig. 2—A recent patent covering aircraft design has a claim which may govern many future innovations

and sale. Let us apply the test of infringement and determine whether or not the unauthorized manufacture, use, or sale of C's knife constitutes an infringement of either one or both of the two claims of A's patent. If all of the following questions can be answered in the affirmative, then C is guilty of the charge of infringement. A similar test can be applied to any patent.

1. *Is A's patent still alive, that is, is the patent less than seventeen years old?*

The date of issue appears upon the face of the document, and thus the answer can be determined readily by obtaining a copy of A's patent.

2. *Are the claims of A's patent valid?*

If C has reason to believe, based upon facts, that all of the infringed claims are invalid, then he can set up

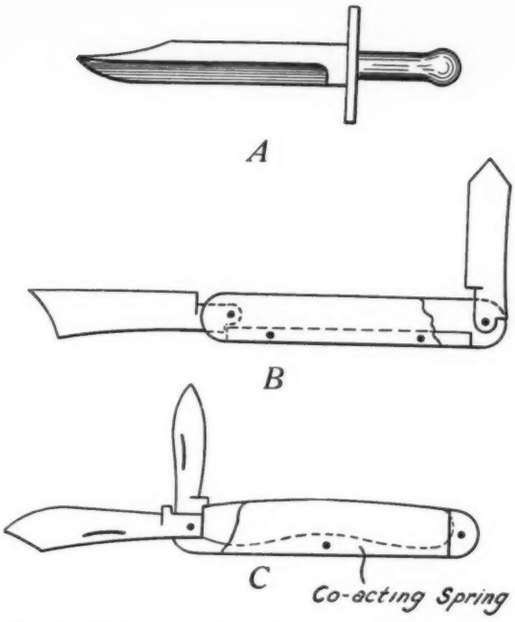


Fig. 3—Improvement inventions may be patentable and still be covered partially by earlier claims

these facts as a good defense in the event that A brings an infringement suit. However, by reason of its issuance by the Patent Office a patent is prima facie valid; but inasmuch as the Patent Office may not, in some cases, have complete knowledge of all the facts that constitute a bar to the issuance of a valid patent there are some patents granted which, when the question of invalidity is raised in a law suit, are later declared invalid by the courts. Such facts that constitute a bar to the issuance of a valid patent may include lack of invention, lack of utility, lack of novelty, prior knowledge or use, prior invention, dedication to the public, abandonment, and various other defects.

3. *Does at least one valid claim of A's patent "read on" C's knife? (A claim "reads on" a knife for example, if there can be found in the knife an element that falls within the purview of each descriptive phase of the claim).*

The answer to this question in an actual patent infringement case is usually extremely difficult, and for this reason the discussion immediately following is set forth with great particularity.

To answer this third question, we must consider each claim separately. With reference to claim 1 of A's patent, it is noted that the claim calls for a knife comprising (1) a handle, and (2) a blade having a cutting edge, (3) *the handle and the blade being formed of one integral piece.* Examining C's knife, Fig. 3*C*, there can be found a handle, and a blade having a cutting edge, but there cannot be found the provision of *the handle and the blade being formed of one integral piece.* Therefore, claim 1 of A's patent does not "read on" C's knife and, consequently, the manufacture, use or sale of C's knife does not constitute an infringement of claim 1 of A's patent.

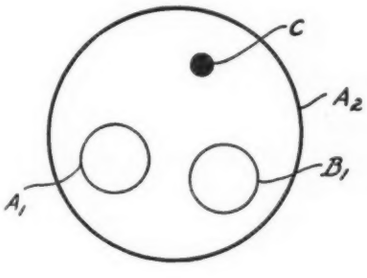


Fig. 4—Patent claims are like a fence that encloses the area to be protected. This area may lie within the fence erected by claims of prior patents

Claim 2 of A's patent merely calls for a knife comprising (1) a handle, and (2) a blade having a cutting edge. Study of C's knife shows that it includes both of these factors. Therefore, claim 2 of A's patent "reads on" C's knife, and its manufacture, use or sale constitutes an infringement. This is shown graphically in Fig. 4. Spot *C*, which represents C's knife, lies within circle A_2, the area covered by claim 2 of A's patent, but spot *C* does not lie within A_1, the area covered by claim 1 of A's patent.

Could Stop Infringement

The fact that C's knife has more parts than A's, and thus constitutes a material advance in the art, does not free C of infringement so long as there can be found in C's knife a handle and a blade having a cutting edge. Hence, upon the strength of claim 2, assuming that it is valid, A could enjoin C from further infringement and make him account for past infringements. However, C could bargain for a license agreement from A, but, because of his past commercial activity, he is put in an unfavorable position to make a good deal. Had C investigated the patent situation before he started commercial activity he would have been in a much better position to bargain, because after commercial activity is once started the value of such alleged infringed patents is increased greatly.

Suppose that C also receives a notice of infringement from B, the inventor of the second knife shown in Fig. 2, which, we will say, is protected by a patent having the following single claim:

> 1. A knife comprising a handle having a recess, a blade having a cutting edge pivoted to one end of the handle, and *a second blade having a cutting edge pivoted to the other end of the handle,* said blades being disposed to move into and out of said recess.

An analysis shows that the claim does not "read on" C's knife, for the reason that there cannot be found in C's knife"—*a second blade having a cutting edge pivoted to the other end of the handle*—" a limiting provision of B's claim. In Fig. 4, note that spot *C*, which represents C's knife, does not lie within circle *B*, which represents the area fenced in by the claim of B's patent. Accordingly, the manufacture, use, or sale of C's knife does not constitute an infringement of B's patent.

One would naturally think, by looking at both A's and B's knives, that if the manufacture, use

or sale of C's knife constituted an infringement of any patent it would be B's, because B's knife looks more like C's than A's does, but appearance is not the test. In the last analysis, B's patent is of little value, as the single claim is too specific in scope. Where it is at all possible, it is advisable to have more than one claim in a patent because if this single claim is declared invalid, the entire patent falls, whereas if the patent contains a number of both broad and narrow claims the patentee can still fall back upon the narrow claims if the broad ones are involved.

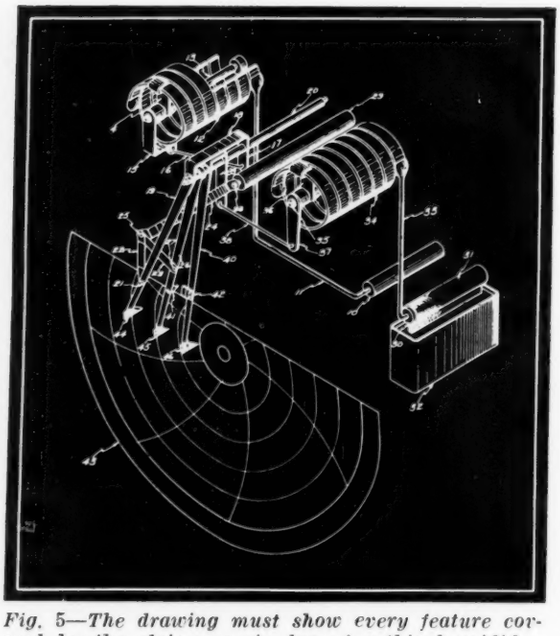


Fig. 5—The drawing must show every feature covered by the claims, as is done for this humidifier

Contrary to the idea entertained by some inventors, a claim, in order to cover as much of the invention as possible, should be devoid of all dispensable features of the invention. The more dispensable features that a claim includes, the less the invention is protected. Consequently, a claim that includes one or more dispensable features gives substantially no protection against infringers, because they can design around the claim by omitting one or more of the features.

Infringement, is not avoided by the substitution of an "equivalent" for one of the dispensable elements of a claim. The range of "equivalents" varies with the character of the invention. Thus, if the invention is a pioneer invention, that is one creating a new field of development, the range of "equivalents" is broad, including almost anything, whereas if the invention represents only a slight improvement over the prior art, the range of "equivalents" is narrow, restricting the patentee fairly closely to the literal meaning of the claim.

Advertising or the securing of a contract to make an infringing article, is not infringement. It is the unauthorized making, using or selling of the patented invention of another that constitutes an infringement. In view of the fact that the monopoly of a patent conferred by the United States extends only throughout the United States and its territories, it is essential that at least one of the unauthorized acts of making, selling or using occurs within this region.

No protection is afforded by the patent law prior to the actual issue of a patent. The terms "Patent Applied For" or "Patent Pending" have no effect in law, but only give information that an application has been filed. However, just as soon as the patent issues, the patentee can enforce his rights, even to the extent of enjoining all purchasers from using the patented article, notwithstanding the fact that it was legally manufactured and sold without his permission during the pending application.

Motive Is Immaterial

The motive or intent with which an act of infringement is committed is immaterial. A person may infringe a patent without even knowing of its existence. This is by reason of the fact that patents are matters of public record, and thus all persons are chargeable with notice of their contents. In infringement matters, only unexpired patents are searched and particularly those that relate to the device in question. This narrows the search down, but even then a great deal of searching is necessary because the failure to find a single patent, if it should be an infringed one, would nullify the investigation. After the search is completed every claim of the selected patents is analyzed separately.

The other phase of the patent situation which should be investigated before marketing an improvement invention, relates to the securing of patent protection upon the novel and improved features of the invention. In the case of C's knife, C now may ask: "How can I obtain a patent for my knife when I cannot manufacture, use or sell it without infringing A's patent?" The answer is: That Patent Office is not concerned with infringement, but only with "anticipation." Thus, a device shown or described in a prior patent or in other prior publications "anticipates" a claim of a subsequent patent, if the said claim "reads on" the prior device. We usually speak of a prior patent or prior publication as anticipating the subsequent patent, but this is not correct, for it is the prior device shown in the patent or publication which anticipates a claim or claims of a subsequent patent.

In the prosecution of a patent application, an examiner searches the prior patents to see if he can find one or more that show and describe a device upon which the claims of the patent application "read on." If he finds such a patent he rejects the claims as being met by the prior art. To overcome this rejection, the inventor may

(Concluded on Page 43)

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Mechanical Devices Pilot Plane

SUCCESS of Wiley Post's record airplane flight around the world is being shared by the developers of the mechanical device which served as his automatic pilot. The precision with which this system, Fig. 1, operates is further proof that virtually no task is too difficult for mechanical devices, once the designer conceives the idea and follows it through to conclusion. Sperry Gyroscope Co. Inc., is the designer of the robot pilot installed in the "Winnie Mae," Post's historic ship.

Two principal units make up the system, the gyro control mounted on the instrument panel of the plane, and a servo unit. Referring to the diagram, Fig. 1, the gyros A and B are air driven from a pump connected to the engine. Gyro A spins with its axle vertical. Relative movement between its axle and supporting frame longitudinally (climb or dive) is converted into corrective positions of the elevator. Relative movement laterally (wing up or wing down) is converted into corrective positions of the ailerons of the airplane.

Gyro B spins with its axle horizontal, and relative movement between its axle and supporting frame (directionally) is converted into corrective positions of the rudder. This gyro carries a disk with knife edges which intercept an equal volume of air, provided also by the pump, at two exhaust ports as long as the plane stays exactly on its course. If the plane yaws, however, the disk remains fixed and the exhaust ports turn about a vertical axis, increasing the flow of air through one port and diminishing it through the other. This changes the pressure at an air valve which, through an air relay, actuates a balanced hydraulic valve to move the piston in the hydraulic servo unit. The piston is connected mechanically to the rudder and moves it in the proper direction to return the airplane to its course.

The same sequence of operations is effected by gyro A, except that this unit carries two

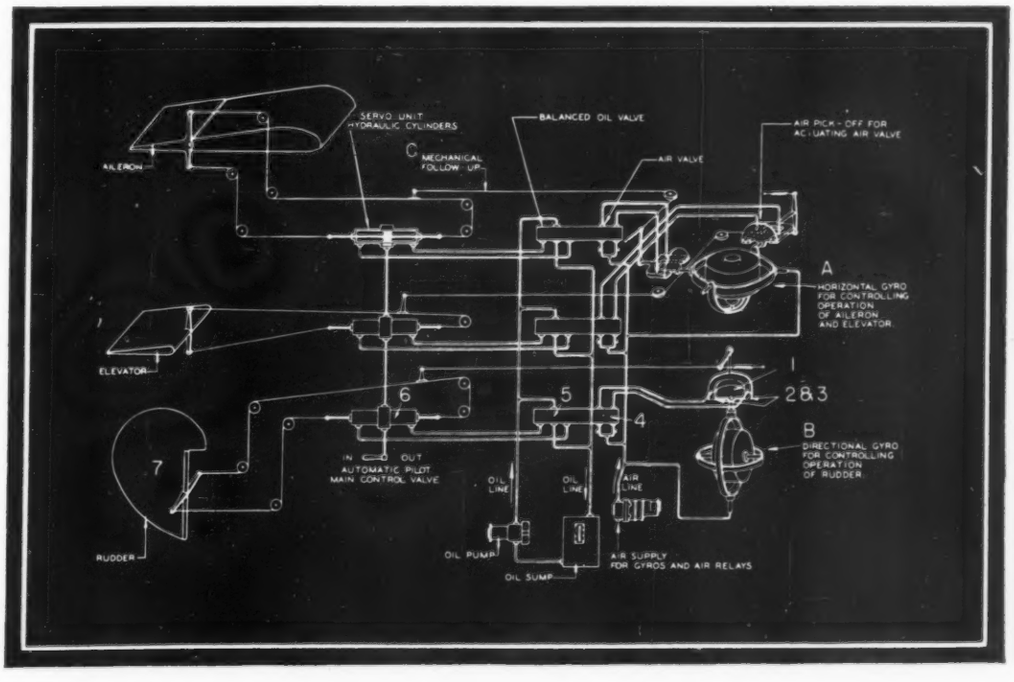


Fig. 1 — Schematic diagram of automatic airplane pilot used by Wiley Post in his record breaking around-the-world flight. The mechanism embodies primarily twin gyros, air pick-off and hydraulic devices which manipulate the rudder, aileron and elevator controls automatically

disks and exhaust port systems, one of which actuates the controls of the elevator and the other the ailerons. The air pick-off and relay system functions instantly for angular displacements of only a quarter of a degree. Since there is no actual contact between the air ports and the disks, there is no reaction on the gyros to disturb them from their fixed position. Weight of the complete automatic pilot is approximately 75 pounds.

Universal Joint Idea in Compressor

PRINCIPLE of the universal joint has given Frank E. Holmes, mechanical engineering department of California Institute of Technology, an idea for a rotary compressor, Fig. 2,

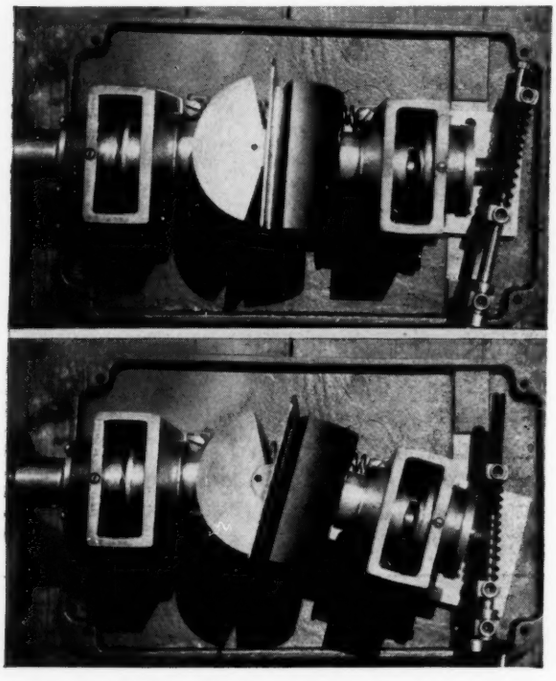


Fig. 2—Variable displacement rotary compressor based on the principle of the universal joint

which now is in the process of development. With a somewhat experimental machine, air has been compressed to 100 pounds per square inch. Mr. Holmes states that there seems to be considerable opportunity for applying a modification of his mechanism to hydraulic transmission of power. Although not much has been done in this direction as yet, his patents have anticipated the possibility.

Referring to the top view, Fig. 2, the universal joint itself is the variable displacement compressor. This joint is surrounded by a casing having the appearance of a hollow cylinder cut into two parts along its axis. The two halves are turned at 90 degrees of each other and are a close fit on the displacers. With the casing removed as shown, it will be noted that the center plate acts as the cylinder head for the displacers or "pistons." These displacers are segments of a solid cylinder mounted in such a manner that their axes are in the same plane and at right angles to each other. The center plate carries two semicylindrical members, thus aligning the displacers and allowing them to oscillate relative to the plate.

Secured rigidly to the main base plate is the left bearing, while the right bearing is supported on a small separate plate so mounted that it can be moved in a horizontal plane by an adjusting mechanism. In starting, it is desirable to set the compressor straight as shown in the top view. After adjustment is made to the position shown in the bottom view, Fig. 2, variations are taken care of automatically by the long coil spring shown on the adjusting shaft—as the discharge is throttled the reaction tends to force the machine back into the position shown in the top view.

The unit has corliss type intake valves and disk or grate type discharge valves in each of the angular faces of the displacers. Discharged air passes through the displacer shaft at the right of the unit. Holes in the casing through which this shaft and also the driving shaft pass are large enough to allow for angularity on each side.

Testing Speed Stroboscopically

SUPPLEMENTING the discussion on the stroboscope (M. D., June, p. 23), it will interest designers to note the application of the device for checking speed of telephone dials. In a recent issue of the *Bell Laboratories Record,* H. Broadwell describes a stroboscopic instrument for this purpose. The device consists of a target, Fig. 3, which can be attached to the finger wheel of the telephone dial, and a tuning fork in a case with an opening through which to view the divisions on the target.

The tuning fork vibrates at 50 cycles per second. Depressing a starting button in the case

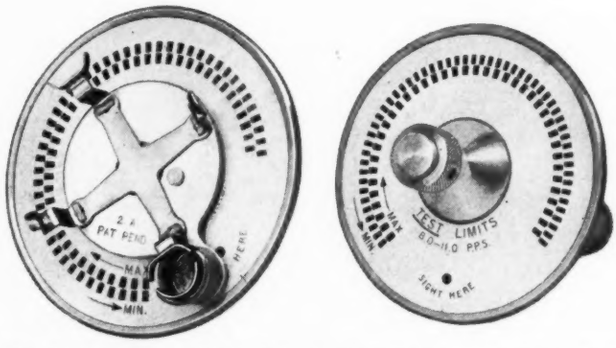


Fig. 3—Target is attached to finger wheel of telephone dial to test speed stroboscopically

causes rotation of a ratchet wheel having teeth arranged to lift flat springs which distend the prongs of the fork to create the vibrations. The case for the fork consists of a box and cover which when slid partly off provides an opening for viewing the target, above which it is placed. Each prong of the fork bears a shutter, the space between them opening and closing as the fork vibrates.

On releasing the dial, if one of the two rows of divisions (representing minimum and maximum speeds) on the target, Fig. 3, appears to stand still when viewed through the fork, the dial is running at the speed for which that row was figured. If the divisions appear to run in the direction of the arrow located alongside the row, the speed is within the limit which the row represents; if in the opposite direction the speed is outside that limit.

New Material Used for Guard

PROTECTION of machine mechanisms, particularly in locations where abrasive dust pervades the atmosphere, is a problem that often confronts designers. An idea in this direction is offered by the application of Pyralin, a Du Pont product, in the form of a transparent hood, Fig. 4, for use over a press designed to produce small porcelain parts.

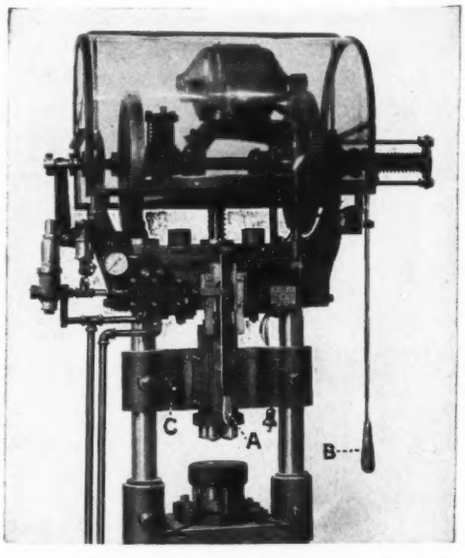


Fig. 4—Transparent hood keeps out dust without hiding mechanism of press

Material processed in the machine is in powder form and usually the locations in which these presses operate are ridden with considerable porcelain dust. This dust, because of its abrasive action, plays havoc with bearings and sliding machine parts which, therefore, must be shielded. The hood enables operators to ascertain the cause of possible disturbances in the drive of the machine.

Employing Steam for Cooling

REFRIGERATION by high vacuum evaporation of water is not new, but its timely application to air conditioning (M. D., Sept., p. 17, 1932) is bringing it more and more to

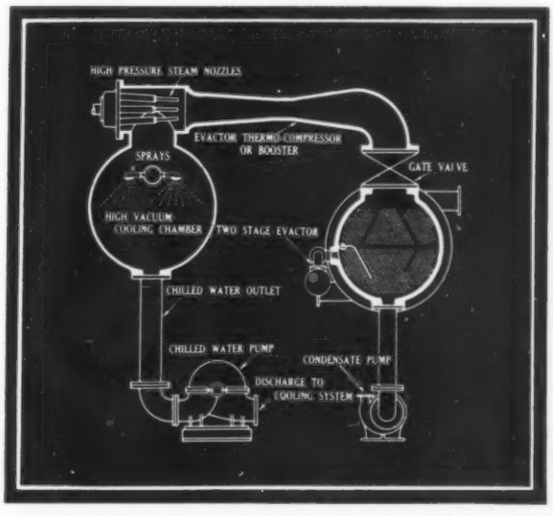


Fig. 5—High pressure steam is used to create vacuum for refrigeration purposes

the attention of engineers. Westinghouse is active in this field as is the Croll-Reynolds Co. Inc. which designed the system depicted in Fig. 5. High vacuum necessary for low temperatures is obtained by means of high pressure steam jets operating in connection with a properly designed combining throat or exhaust piece. Vacuum developed in the closed cooling chamber causes the water to boil or evaporate, the heat required for the evaporation being taken from the water with consequent cooling of the water itself. The steam jet thermocompressor picks up the vapor caused by boiling or flashing in the cooling chamber and discharges it with the high pressure steam into the surface condenser.

Several advantages in air conditioning by means of steam jet refrigeration are set forth by Westinghouse. The temperature drop between cold water in the heat exchanger or cooling coil and the air passing over it is much less, other things being equal, than it is in the case of any other refrigerant. Therefore, for a given amount of refrigeration, a smaller cooling coil can be used. Also since water is the refrigerant there is the possibility of employing a water spray and blowing the air to be conditioned directly through this cold water, eliminating the cooling coil altogether. In this way the water would both cool and wash the air.

Cam Contour Controls Pres Be

Synchronizes Motio

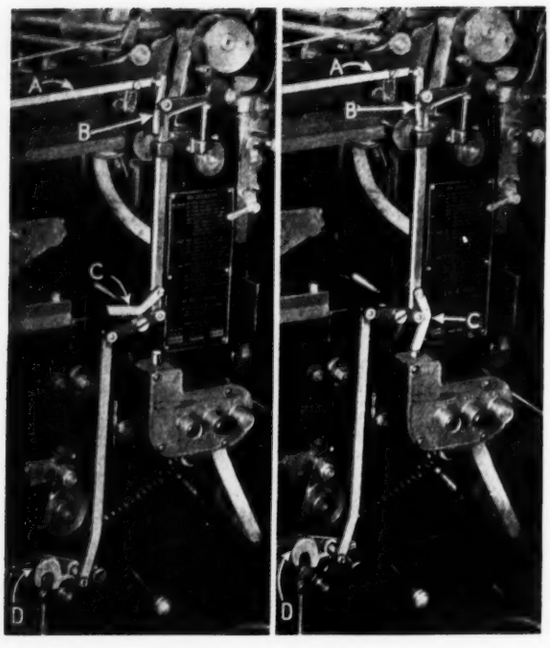


Fig. 1—Mechanism will stop impression if sheet fails to go through press correctly. In arrangement at left, element C is not in position to stop press

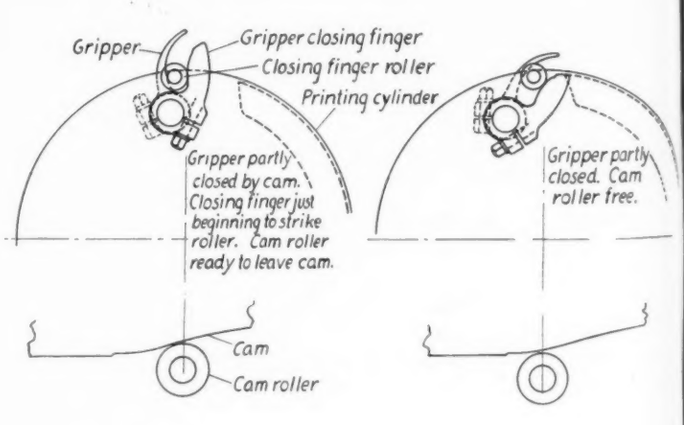
AN OLD, old story frequently bobs up that tells of the designer who never saw a cow yet designed a milking machine. Such an instance belongs to an earlier generation, for today's designer probably would know as much about the cow and the method of milking her as does the man who has to milk her by hand. Yet, all too often, machines have been designed by men who knew little about the problems of their operation, outside of strictly mechanical difficulties, and nothing of the phsychology of the types of men who operate them. Fortunately this method of design is on its way out.

One machine that never had to overcome the dislike of the workman is the style B automatic printing press, Fig. 2, manufactured by Kelly Press division of American Type Founders Co., Elizabeth, N. J. Designed by W. M. Kelly, a man with considerable experience as a practical printer, this machine was developed especially so that all operating parts would be readily accessible, adjustments simplified and all operations made automatic.

One of the most important necessities of the design was the synchronization of the linear speed of the flat bed and that of the rotating two-revolution cylinder during time of printing. This synchronizing mechanism, shown in cross section in Fig. 7, consists of a traveling gear, a crosshead, driving gear and crank cam. It is the result of considerable experiment, and was found to be a greatly simplified method of obtaining this synchronization.

A stationary rack on the press frame, Fig. 7, and a rack on the reciprocating bed mesh with the traveling gear which can be seen toward the left of Fig. 3. Use of these two racks multiplies the linear speed of the bed by two in comparison with the peripheral speed of the traveling gear.

Power is applied to the driving gear, Fig. 7, made from vanadium iron for strength and wear. Cut in this driving gear is a slot which is slidably fitted a crank block shown at the rear of the traveling gear in Fig. 3. This crank block, the pin running through it which it actuates, the cam rollers and the crosshead block mounted on this pin, are the controlling elements of the movement. The two rollers of special bronze run on the pin entering the deep cam. Stresses


Gripper
Gripper closing finger
Closing finger roller
Printing cylinder
Gripper partly closed by cam. Closing finger just beginning to strike roller. Cam roller ready to leave cam.
Gripper partly closed. Cam roller free.
Cam
Cam roller

Bed Speed,

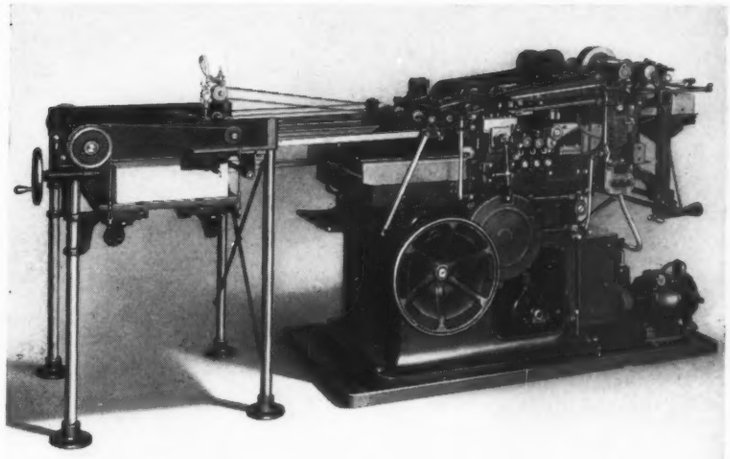


Fig. 2—Automatic printing press is controlled by the sheets of paper as they pass through the machine

thus are divided in the working section of the cam.

Motion of the crank block in the slot of the driving gear is controlled by the cam rollers which govern its distance from the center of the gear by following the contour of the closed crank cam. On the other end of this pin is the crosshead block, Fig. 7, arranged to impart to the crosshead the horizontal reciprocating motion received from the driving gear. The crosshead block slides vertically in a groove in the crosshead, while the crosshead itself has through its center a pin on which the traveling gear rotates and by which the traveling gear obtains its forward and backward motion for actuating the press bed.

The contour of the cam, as it changes the distance of the crank block from the center of the driving gear, varies the length of throw between the driving gear and cross head and controls the horizontal speed of the crosshead with relation to peripheral speed of the driving gear, a constant quantity. Thus by careful development and hardening of the cam contour, a linear speed of bed is maintained which is synchronized with the peripheral speed of the rotating printing cylinder during the printing stroke.

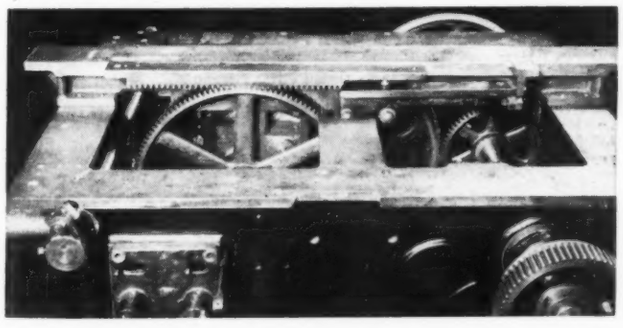


Fig. 3—Driving gear, right center, revolves at constant speed while speed of traveling gear, left, is synchronized with rotary motion of printing cylinder

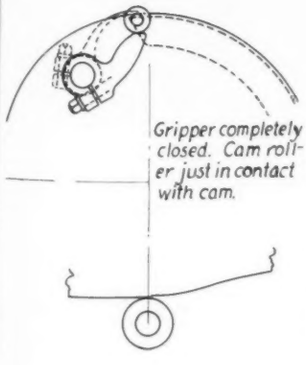


Fig. 4—A final closing finger on the printing cylinder gives positive action of paper grippers and insures register at all speeds

Gripper Design Important

One problem that always comes up in the design of any machine designed to handle separate sheets of paper for printing, folding, gumming or similar operations is that of the paper gripper mechanism. Systems which have been applied successfully include the tumbler type which are arranged to close at a certain point in the cycle of operation, and cam-closed grippers. These systems are suitable for large presses.

In order that the gripping mechanism on the rotating cylinder of this small press be fully automatic and infallible each time a sheet is brought into position by an air operated feeder, a combined system of a gear-actuated and a cam and lever-operated gripper is employed. The operation of holding the sheet as distinct from that of gripping the sheet initially is done by the gear mechanism shown in Fig. 5. Grippers such as *a*, are mounted along gripper shaft *b*, mounted in turn in the rotating cylinder. To this shaft is keyed bevel gear *c*, actuated by gear *d*. Mounted on the same shaft with bevel gear *d* is spur gear *e*.

Reciprocating motion for opening and closing the grippers is obtained by the movement of rack *f* across gear *e*. This rack receives its motion from sliding shaft *g* on which it is mounted. A cam *l* mounted on the bed of the press contacts roller *k* on lever *h*. As the bed moves reciprocal-

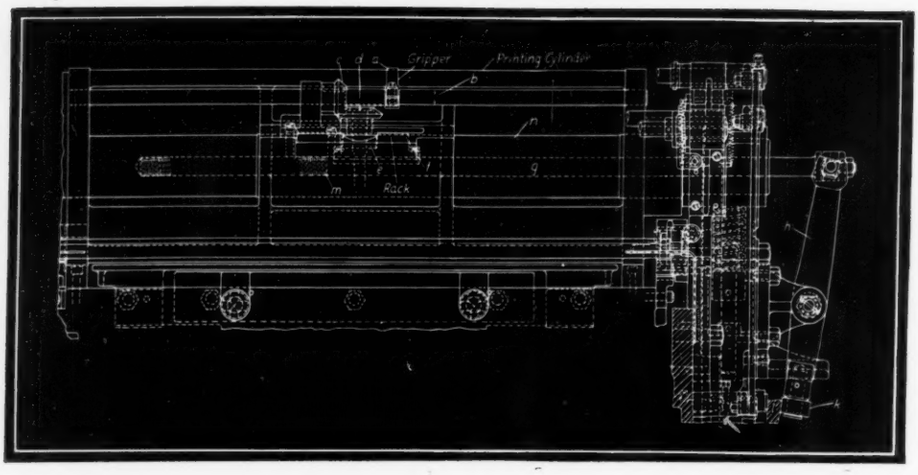
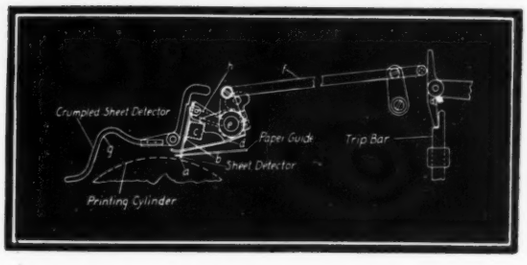


Fig. 5—Gear mechanism operating through the cylinder actuates the grippers which hold the sheet in position

Fig. 6—Sheet detectors must be opened by the paper before the press can continue operation



ly, the contour of the cam moves the bottom of lever *h* outwardly, forcing shaft *g* in against the pressure of spring *m* and thus turning the gears and the grippers, closing them. Along the recessed portions of the cam, the spring returns shaft *g* to its original position and the grippers are opened, releasing the sheet. To secure this method of operation it is essential to place shaft *g* in a hole drilled into the center of the cylinder shaft *n* by gun drilling methods (the only method of production that would result in a hole of sufficient accuracy).

While this gear mechanism is accurate and efficient for holding the sheet, some difficulty was experienced in combating gear backlash so that gripping would be immediate and positive, a necessary condition to insure register at all speeds. To overcome this, a "final closing" finger was placed on the gripper shaft of the printing cylinder. This finger assures positive closing and augments the gear mechanism during such closing. Its action, operating through the gripper shaft and gears referred to in the foregoing, tends to lift roller *k* away from the cam during the closing cycle, this roller contacting a higher portion of the cam later to effect positive holding of the sheet. The relationship of the closing roller, gripper finger and the cam and cam roller during one cycle of closing is shown in Fig. 4. By employment of this combined method there is no "give" or spring in the grippers and hairline register (exact correspondence of lines or colors) is made possible. No gripper rebound is encountered.

Sheet Controls Operation

Operation of the press is controlled by the sheet at all times, accomplished through the sheet detectors shown in Fig. 6. When a sheet comes through the press as it should, passing to the paper guides, it opens the sheet detectors and is taken by the grippers. If it comes through out of square or out of time, or if a torn or imperfect sheet comes through, one or both of the sheet detectors remain locked on the bar, automatically cutting off the feed operation and stopping the press. The mechanism, in conjunction with the crumpled sheet detector, also shown in Fig. 6, makes the feeding mechanism practically accident proof.

Detectors Must Move

Whenever a sheet comes through it moves the light detector strip *a* to the left, thus clearing its projection *b* from under stationary bar *c*. The sheet then lifts strip *d*, thus turning shaft *e* and moving bar *f* to the right, a movement necessary to continued operation of the press. Position of the detectors and strip *d* are adjusted by the thumb screw.

Should a sheet crumple, its action would be to raise the crumpled sheet detector *g* which is placed centrally between the two sheet detectors. Movement of the detector *g* would hold down bar *h*, thus preventing rotation of shaft *e* and action of bar *f* in the same manner as though the sheet detectors were still under bar *c*.

Fig. 1 shows how the detectors control the press, the illustration at the left showing the position of the levers when the press is operating, and that at the right their position when the press is stopped. Elements *A* and *B* of these illustrations also can be seen in Fig. 6. In the illustration at the left of Fig. 1 the sheet has gone through correctly, opening the sheet detectors which allow rod *A* to move to the right to trip pawl *B*. At the right, the sheet has come down out of square or out of time (or an imper-

fect sheet has come down), the sheet detectors have not been opened together, thus preventing tripping of pawl *B*. This action has been transmitted downward along the vertical rods to hook *D*, obviating the printing impression by lifting the hook. Power is cut off simultaneously and the press stopped through action of pawl *C*. This arrangement prevents bunching of sheets, with resultant injury to plates or form and possible damage to the press itself.

Controls Are Built In

Electric controls used on this press have been built into the design to afford the most homogeneous machine possible. The starting switch is a flap type switch which picks up the load by increasing the power in successive stages. The entire drive also has been built into the base of the press. It may be seen through the side in Fig. 2. Inasmuch as the presses have to operate under all conditions of power supply and in all countries, motors are limited in size and can be applied with characteristics satisfying any of the conditions to be met. V-belts were selected as the means of transmitting the power from the motor to the gears because they fill the need of being able to absorb shock if some obstruction enter the press, and yet they provide efficient operation.

Although it would be impossible in a limited space to consider all of the design features incorporated in this press, there remain one or two innovations that are especially worthy of attention. One of these is a horizontal setscrew developed by the makers of the press. It was found that negligence on the part of the pressman who might fail to tighten a vertical setscrew sufficiently might result in damage to the press as the screw would jar loose and fall into the mechanism. The parts therefore were redesigned so that the setscrews would come in horizontally. The screws themselves have one flattened side and fit into a hole which has a similar cross section. The open side of this hole bears on the part to be held. When the screw is tightened, the threads have a cam effect, tightening against the part. Should the screw be overlooked and not tightened, it cannot shake out into the press.

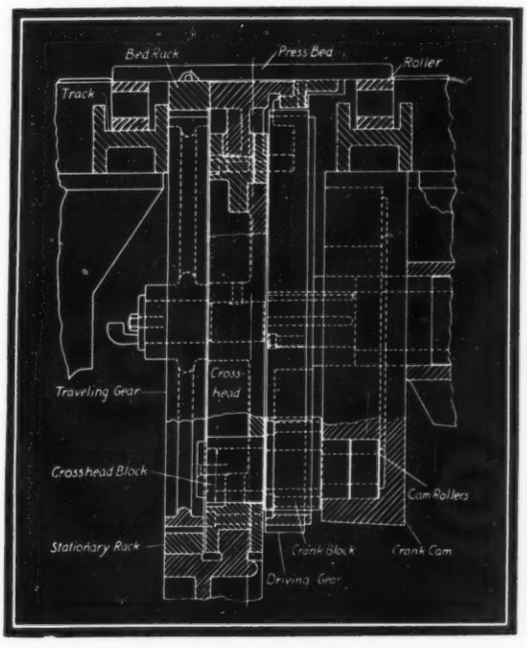


Fig. 7—Synchronization is obtained by the correct design of a closed cam

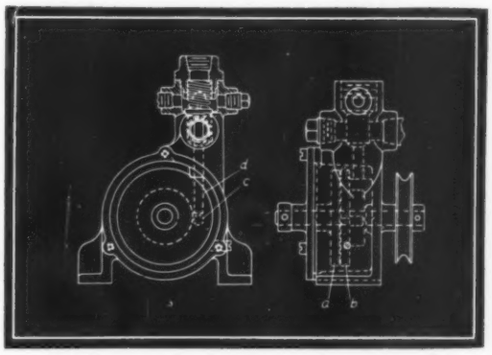


Fig. 8—Viscosity of oil between two rotating disks controls flow of gas

Employs Unique Gas Control

Long continued tests indicated to the designer that a gas flame was the best method of dispelling static electricity and drying the sheets after they came from the press. Drying is necessary so that the sheets will not smear or "offset" on to the sheet stacked on top of them. However, as the press is wholly automatic and might be stopped by a crumpled or irregular sheet with the attendant some distance away, it might happen that a sheet would be stopped in its passage above the gas flame. Such an instance could easily result in a fire, so it was necessary to devise a gas controller that would turn off the gas every time the press stopped.

This controller is shown in Fig. 8. The viscosity of the oil in the unit is the controlling force. Disk *a*, driven through its shaft and the pulley, is connected to a moving shaft of the machine. Whenever disk *a* turns, the viscosity of the oil between it and disk *b*, operating through a space of 0.006 to 0.007 inch, picks up this disk and turns it also. This rotation continues until stud *c* comes under the stem of valve *d*, raising the valve against the pressure of its spring and permitting flow of gas. The oil viscosity holds disk *b* in this position. Should power on the press be shut off, disk *a* would stop, the rotating effect of the oil on disk *b* would cease and the valve spring would seat the valve, shutting off the flow of gas and consequently extinguishing the flame.

By Harold F. Shepherd

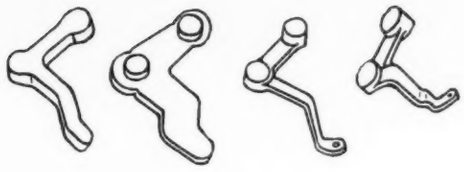


Fig. 1—Cold swaging by powerful presses supplements the simpler methods of blanking

Considering Design fro

Production St

DESIGNERS who employ special shapes extensively have succeeded in adapting to their use forms that may be prepared for cold rolling or drawing by a hot pass or two on regular merchant bar mills. Other designers have devised shapes of an intricacy that is justified only by special consideration of costs and results.

Special cold drawn shapes are available in lots as small as 300 pounds at a cost sufficiently low to effect great savings over milling from the bar, a tedious process not necessarily more accurate than drawing. This economy is possible because the set-up for drawing special lots involves only the dies while special cold rolled shapes require individual rolls and more or less dismantling and reassembling of the mill. Fortunately, most of these shapes are light and within the 1 to 1¼-inch diameter capacity of the average draw bench.

Drawing naturally presents some possibilities not available in cold rolling. In the latter process the work must draft to the pitch line of the rolls while in drawing no such requirement exists. Thus a pinion bar of three or four teeth might be rolled while one of five or more teeth could not be so produced.

Should Visualize Die

However, in spite of the opportunities presented in drawing, the designer of the shape should visualize the die that will be required. A simple example may be improvised to illustrate the principles involved. Obviously sharp corners x, Fig. 3, will wear away rapidly and limit die life or accuracy of form. Certainly die element y should be stout enough to stand up under the draft and, as the tool must be hardened, fillets at z would seem to be essential.

Cold processed bars should not be machined locally or even key seated, as removal of a part of the cold worked surface results in relief of internal strain along one side only and the piece bows or warps. Turned and ground and turned and polished rounds are available when keyseating or other machining is required.

Extrusion accomplishes great reductions at a single operation. The heat produced by the operation keeps the metal plastic during the cycle. It is available only for nonferrous metal a condition which makes it advisable for designers about to employ shapes to include processing among the factors determining the metal chosen for the detail.

Essentially, the process involves the forcing of a hot billet of metal contained in a heated cylinder through a die of the required shape by the action of an hydraulically actuated plunger fitted with some form of obturator.

In discussing extrusion of this class, analogies sometimes are drawn between the metal flow and that of liquids through orifices. If these parallels were exact, the flow of metal through the various geometrical elements of a section would be at exactly the same velocity under the fixed head acting on the billet. Under such ideal conditions shapes like Fig. 4 might be extruded without questioning the quality of metal in tongue x. An iron sample however, Fig. 2, which has been sectioned and etched, shows that the

Fig. 2—Flow of metal as indicated by slag lines is of viscous character

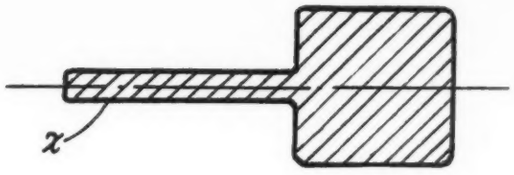


Fig. 4—Characteristics of metal flow make sections such as this one undesirable

Part IX—Drawing, Extrusion, Pressing

ign from the

on Standpoint

flow is viscous as indicated by the long continuous slag lines. Under these conditions the flow through an element of large area is naturally faster than through the more restricted part of the die opening. It has been shown that the vena contracta is as evident in extrusion as in the flow of fluids, the bar product being smaller in area than the die orifice. Minor irregularities in section perhaps may be compensated for by changes in the approach angle in the die, thus varying the orifice coefficient to some extent but hardly enough to justify Fig. 4.

Fig. 5 shows the classical apparatus for extruding lead traps. The orifice is adjustable by shifting plate *A* to limit extrusion on the inner side of the bends. In impact extrusion careless die setting or presses with worn guides often cause crooked work to be developed. All of these circumstances are evidence that the sections of shapes should be of fairly uniform thickness to insure extrusion without internal strain or warping.

Obviously shapes whether rolled, drawn or extruded should be submitted not only for quotation but for approval by the mill.

Shapes are sliced to provide profiled blanks for many purposes. Although this means of blank production may be regarded as competitive with die blanking from the rolled sheet, it possesses a field of its own.

In considering the means to be used for producing blanks of less regular form, as for instance a profile like Fig. 4, the whole punch area as opposed to the whole shear area is not to be compared, but rather the weakest punch element at x as compared to the thickness. By such comparisons the justification or necessity of blanking by slicing cold drawn or extruded bars is at once evident.

This practice has other advantages. In die blanking the sheared edge, which is the profiled edge, is left rough. The only accurate means of making it sightly or capable of receiving plating is by shaving in one to three successive punch and die operations. The blank cut from shaped bars is rough only on its two plane surfaces which may be finished by any of a number of processes.

To supplement these two simple methods of blanking which fail to meet all requirements, cold swaging by powerful modern presses is made available. Fig. 1 shows the successive operations of blanking, swaging, trimming and bending.

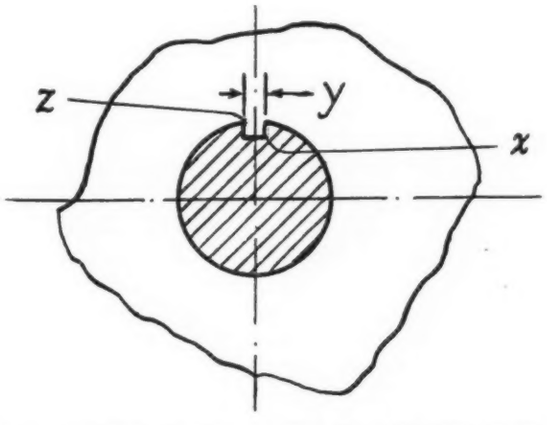


Fig. 3—Sharp corners on the die will wear away rapidly and limit the die life

High Pressures Avoided

Note that the terrific pressures required in coining are avoided since the job is not confined. Nevertheless, the required press capacity when working on soft steel is about 100 tons per square inch of swaged area. The hubs are struck but lightly, the stock being of a thickness little greater than the hub length. Every effort is made by the designer to reduce the swaged area as much as possible. Use of brass for the part lightens the work somewhat to approximately 75 tons per square inch of area.

The advantages of this method over drop forging for small work lie chiefly in the lack of necessity for operative skill. To drop forge the

part, the bar first must be heated and then broken down in an impression in the side of the die so as to register approximately with the main die cavity. It then may require striking and stripping several times.

The swaging operation is controlled entirely by die design. Once the dies are set, material supplied and the press in motion the operations are accurate and, it might be said, inevitable.

Brass Forming Successful

Serious efforts to form sound well worked brass and aluminum bars into forms, once considered possible only by casting, are succeeding on every hand. These operations are carried out in heavier power presses and in hydraulic presses. The punch elements descending upon the hot and plastic slug pierces, swages, extrudes and coins until all the die cavities are full. The blank volume is gaged carefully but some flash is permitted to insure filling.

Symmetry of form, even to the ideal of devising only figures of revolution as far as possible, is essential. The metal in the slug should have about an equal distance to flow in all directions, otherwise excessive local flash and unequal swaging or extrusion may strain the tools or result in a poor product.

A British invention makes possible the production of pierced or "cored" hour glass or double flanged forms in a vertical single acting press. The die proper, Fig. 6, is split and fitted into a tapered socket in the die base. It is lifted

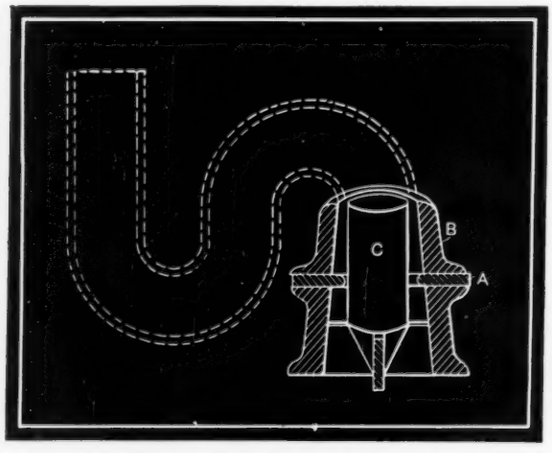


Fig. 5—Orifice on apparatus for extruding lead traps is adjustable to limit extrusion

and parted to release the finished forging. In designing parts for these operations it is essential that the section of the blank be great enough to form without buckling as advised in discussing forging machine operations, (M. D., Jan.).

For this purpose the size of the slug should be calculated by the designer and it should be positioned graphically on the die layout so that its probable stability or instability under piercing, extrusion or upsetting may be predicted. This drafting-room operation is shown schematically by the coarse chain lines in Fig. 6.

Brass castings requiring sizing and a smooth finish for plating are being worked in the same way, the die being practically closed and the operation literally a coining one. This has the advantage of preserving the geometry of the piece often utterly destroyed by careless buffing. Here, too, areas should be limited especially as castings are liable to vary and an unclosed side

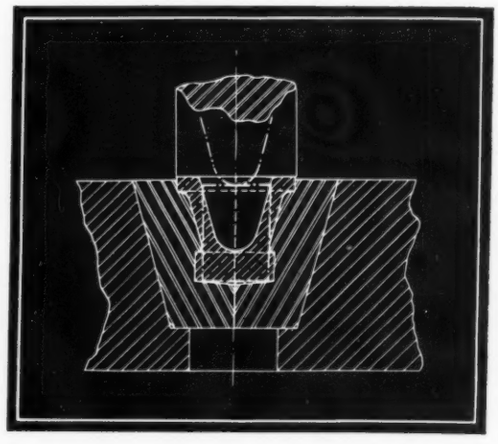


Fig. 6—Die proper is split and fitted into a tapered socket in the die base

area in the die where polish is omitted may offer immense relief. This often is required by inaccessability in buffing without great loss of appearance and should be no less desirable in the pressed job.

Various researches have defined the properties and limitations of nonferrous forging metals. It is concluded that Alpha brass (zinc under 36 per cent) is cold worked easily. Beta brass with zinc between 36 and 45 per cent is best adapted to hot work. Gamma brass with more than 48 per cent zinc is not easily forged hot or cold. Pure copper is more plastic than Alpha and less plastic than Beta brass but is said to form a black oxide when forged hot which is hard on dies. One to three per cent lead seems to aid both forgeability and machinability of forging brasses.

Duralumin may be worked hot in the same way as brass and so may the various other aluminum forging alloys on special advice from the maker as to forging temperatures, etc.

The press knock out makes any special provision for draft rather unnecessary in forging by this method. The effects of shrinkage are the same as those discussed in relation to drop forging dies, (M. D., Jan.) and should be considered.

An article on this subject published in a previous issue of MACHINE DESIGN is:

"Cold Drawn Shapes and Extruded Sections Offer Economy in Designing," by Harold B. Veith, Sept., 1931, p. 48.

Stratosphere Craft Presents Materials Problem

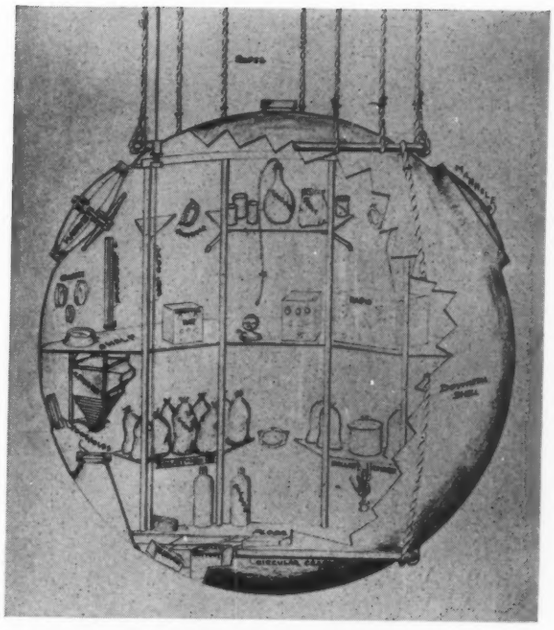


Fig. 1—Interior of Piccard stratosphere gondola constructed of welded dowmetal plates

SINCE Prof. Auguste Piccard's successful 52,000-foot balloon flight into the rarefied atmosphere known as the stratosphere, much speculation has prevailed regarding the suitability of this medium for high speed transportation.

Thus far interest and development in stratosphere craft have been concentrated almost entirely in countries abroad. However, the projected stratosphere flight at Chicago, which at the time this is being written still is in the preparatory stage, undoubtedly will stimulate increased attention among engineers in this country. Designers of machinery will be interested, in particular, in the construction of the stratosphere gondola, Fig. 1, and the influence of some of the problems on the selection of the materials that are employed.

Dowmetal was chosen for the gondola, designed as a sphere to offer equal resistance to atmospheric pressure. At the 11 mile height Lieut-Commander T. G. W. Settle expects to reach, 1.4 pounds air pressure prevails as against the normal pressure of 14 pounds per square inch at sea level.

Four Factors Govern Choice of Metal

In commenting on the use of dowmetal for the gondola, Dr. Jean Piccard, who supervised the construction, named four main factors to be considered, namely light weight, airtightness, tensile strength and resistance to deformation. Calculations made by the engineers of the Dow Chemical Co., Midland, Mich., disclose that a shell made entirely of sheets of this material has a bursting pressure of about 100 pounds per square inch, allowing an ample safety margin. The metal itself is obtained from a liquid, a brine pumped from a 1200-foot depth under the Midland area. Aluminum, according to Dr. Piccard, could have been used as it was by his brother Auguste Piccard; however, dowmetal is stronger and one-third lighter than aluminum.

Fabrication of the seven-foot sphere consisted in casting the metal in the form of sheets, after which the segments were formed in an hydraulic press and welded together. Sections were cut off to provide for circular pole pieces at the top and bottom of the ball, thus avoiding the convergence of a large number of welds. The segments, resembling the sections of an orange peel, were tack welded together around a rigid steel form, top and bottom pieces were welded into position and the spaces between the tack welds filled in. Seams were not peened since the engineers felt that while hammering might increase the strength of the welds it would decrease the resistance of the adjacent metal. Tests indicated that the tensile strength of the welds was 90 per cent of the strength of the plates.

As shown in the illustrations two quick-acting

doors are provided, and ten port holes permit observation, photography and entrance of light. All are airtight because by artificial means the air inside must be maintained at a nearly normal sea level condition. Each entrance embodies an outside hinged door and an inside loose door, both elliptical in shape. A screw arrangement is provided between the two sections so that they may be made tight by means of a handwheel inside to draw the two sections against rubber gaskets.

Rubber Gaskets Seal Windows

Eight of the round windows have optical glass screwed against rubber gaskets in the metal frame. One window is set in a horizontal plane about 22 inches from the bottom of the sphere. On its face are cross wires and movable tables to permit measurement of the flight's direction by reference to a nearby compass. Two special quartz glass windows, each about three inches in diameter, are located in the upper section of the sphere for installation of the spectrograph. Five small openings in the top of the gondola admit instrument wires and balloon cords.

Inside the sphere Lieut-Commander Settle will have a living space four feet across, surrounded by three circular shelves to be used as storage for equipment, food, instruments and ballast, as well as to provide tables upon which necessary experiments may be made. For the ballast, consisting of about 2200 pounds of lead dust, a funnel-shape releasing device has been installed. This unit makes possible the release of the dust in desired amounts without permitting air to escape with it.

The sphere is designed to be suspended from a balloon by means of a circular metal ring at the lower part of the gondola, connected by bands of metal to a similar ring at the upper part. These bands are attached by ropes to a tubular ring placed a few feet above the sphere; to this ring the ropes of the balloon will be attached.

May Influence Rocket Development

The stratosphere flight in Chicago will be watched closely in this country and abroad. Such ventures may have a direct bearing on the development of the rocket which holds the hopes of many engineers as the means of conquering the stratosphere for commercial transportation of mail, etc. Results of the flight also may have a telling effect on development of stratosphere airplanes such as the steam driven plane tested recently on the west coast. Superchargers to some extent adapt the conventional gasoline airplane engine to flying in rarefied atmospheres, but there still are many problems to overcome in the employment of this type of engine for the purpose. The steam driven airplane on the other hand is capable of attaining greater efficiency as it reaches the high altitudes that will be investigated during the Piccard flight from Chicago.

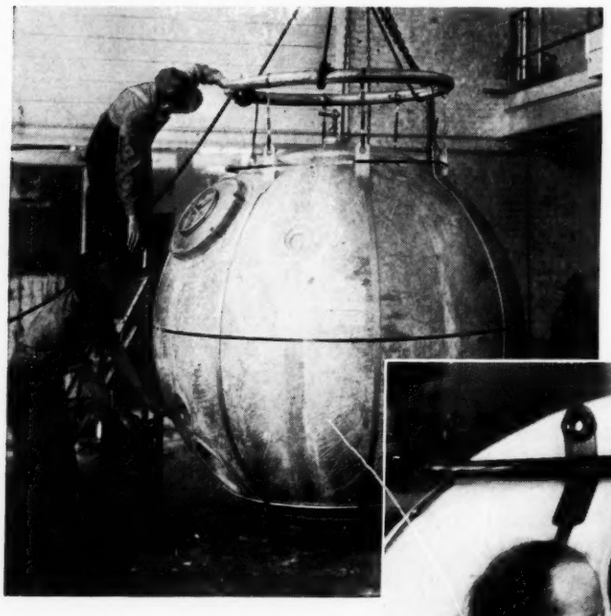


Fig. 2—(Above)—Testing the sphere during the development stages. Fig. 3—(Right)—Brothers Auguste and Jean Piccard inspect the elliptical doors of the gondola

Plus or Minus Five Thousandths!

THIS article might well be entitled "An Inspection Tragedy". It contains a protest, treated in fiction style, against the 'policy' followed by some designers of complicating production by adding unnecessary tolerances to machine cuts, foundry specifications, etc. Careful consideration of the need for such tolerances should eliminate much unnecessary waste in production.

By Waldo Hutchinson

FUR was flying around the shop the other day. It all started because the old man happened to take one of his periodic walks through the plant. A lot of fellows in the plant wish he would keep his nose in his private office "where it belongs." It seems that whenever he takes a crazy notion to go rambling around the place someone gets his foot into it.

This time it just happened to be Frank, the chief inspector. The old man was sniffing around in the machine shop, and happened to run into a pile of scrap over in the corner. He beckoned to Joe, the foreman. Joe eased over toward the scrap pile, with a "What, *now*?" look on his face.

Is this stuff all scrap?" the old man wanted to know, picking up a partly machined "364-bracket."

Joe gazed gingerly at the rejected part. "Yes, sir," he answered, taking the bracket from the old man's hands and scrutinizing it. "This '364' was cut three thousands undersize in milling the face."

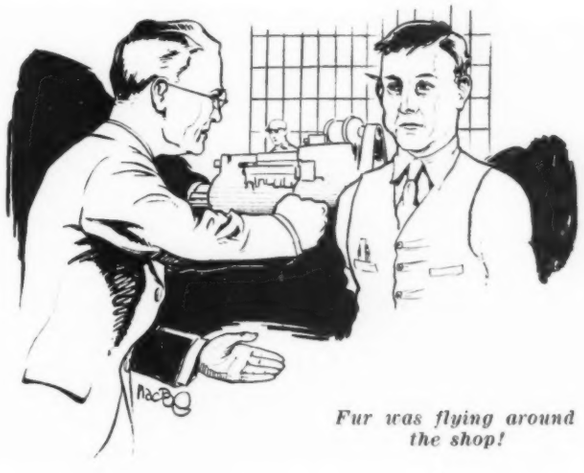
The old man began to boil up. "Three thousandths"? he repeated, heatedly, "It could still be *used*, couldn't it? What's the tolerance on that cut?"

The foreman scratched his head reflectively. "Eh, *plus and minus, five thousandths,*" he said.

The old man pursed his lips. "What's the matter,—machine need tuning up?" He began to fumble around for another part, so as not to embarrass Joe by seeming too direct.

The foreman thought awhile. "No, I reckon not," he answered. "But we just broke in a young fellow on that machine and, well I suppose we can't expect a green-horn to work to such close limits, without a rejected part once in a while." There was just a trace of irony in his tone. He knew the old man liked the idea of working in younger fellows on the machines.

"Well, it shouldn't take a skilled machinist to run a miller," the old man came back. But then he added "Why are the limits so close for that facing cut?"



Fur was flying around the shop!

This was a poser for Joe, and all he could do was pass the buck. "The *print* calls for that tolerance," he said. This was no answer to the old man's question, but Joe was machine shop foreman—not designer. Somehow the old man realized that Joe's reply carried a dig at "engineering," and he quickly began to finger another piece

of scrap. "What's wrong with this one?" he asked.

Joe gave it the once over. "Blowholes," he announced, after turning it around a couple of times. He got out his pencil and indicated the tiny recesses in the casting which a lathe operation had uncovered.

The old man put on his specs and squinted at the place where Joe's pencil rested. "I don't see —oh, yes, *there* they are!" said the boss, "but the casting is just as strong, isn't it?"

"Yes, I should think so," replied the foreman,

He quietly laid down the law to that official

"but the print says: 'casting must be entirely free from sand holes, blow holes, and other foundry imperfections.' "

Well, the old man saw that he could get nothing on Joe. All the foreman did was to stick up for his men and pass the buck to Inspection and Engineering. The old man liked the way the new time study man was standardizing the jobs —making them easy for new men to break in on them in a few hours. And he had sense enough to see that a new man must be expected to spoil a piece once in a while—especially on close-limit work. But why in thunder did the limits have to be so darned close.

What he could do, though—and often did—was to get the foundry on the wire and burn up the switchboard telling them about the terrible castings they were sending. But the best foundry in the country can't produce perfect castings on a production basis—at minimum prices—without an occasional hitch.

But there was Inspection. That was it! By criminently he'd call Frank onto the carpet! Frank came in answer to the call.

"I was looking over the rejections, this morning," began his nibs. "Can't you fellows use a little judgment about turning down some of those parts. I realize that some blowholes are invisible until after they come off the machines. I don't expect you to save machine work by rejecting bad castings before you can *see* the holes. But a lot of stuff is perfectly O. K. from an assembly and appearance standpoint. There's no sense in being too finicky about points that don't affect the utility of the product."

"Well," drawled Frank, shifting his weight to the other foot, and coughing a trifle nervously, "we've got to follow the *drawings* chief. I....."

The chief flared up. There it was again. "Drawings!—Prints!—Engin—"Dammit!" he said, "the engineering department makes the prints to show the parts as we *desire* to have them. But a little discrepancy one way or the other doesn't necessarily call for a rejection. An inspector should use a little *judgment!*"

Frank's pride was injured a little at that word 'judgment.' He knew as well as anyone that many pieces were being scrapped which could be pressed into service.

"Listen, chief," he began. "If I could personally inspect every part we could save a lot of scrap. But it's much cheaper to put low-priced 'checkers' on the job—hand them the print, and tell them to be governed by it. If we wanted to pay for inspectors who *had* judgment we might solve the problem. But to my notion that shouldn't be necessary. The checkers should have drawings they could follow without danger of throwing out good material."

The old man began to pace the floor. "Well, what's the answer—in your opinion?" The question sounded more like a challenge than a query.

"I believe, chief, that our drawings should all be gone over and all unnecessarily close tolerances removed. You know Benson, in the engineering, has a pet theory that all machine work should be done within five thousandths. Every machine cut marked on drawings is labeled 'plus and minus, 0.005' whether it needs it or not And every casting specification has tacked onto it: 'Must be free from blowholes, sandholes, warpage, or distortion of any kind.' Its a piece of nonsense, if you ask me."

The next day the old man walked into the office of the chief engineer, and quietly laid down the law to that official. He forgot about the latter's ability to prove anything he chose by a few deft manipulations of the slide rule. In plain words the boss told the chief engineer that what was wanted was low cost production—not hair-line accuracy in drawings. He explained that theory was tolerable only insofar as it facilitated practice, and that low operating costs were more desirable than adherence to a policy. Therefore the old habit of sticking to 'plus and minus 0.005' must pass into oblivion.

Ultimate results of the upheaval were very gratifying. The only thing is that while Frank knows that most of the credit is due him for the change, he still kind of squirms guiltily whenever he recalls how he sailed into the old man!

Needle Bearings—Unique Machine Elements

By Allen F. Clark
Associate Editor, Machine Design

ALTHOUGH bearings using small rollers or needles were developed originally over thirty years ago, widespread application was delayed until the advent of a commercially practical centerless grinder. Even the first of these rollers were made on a grinder of this type, the machine being one of the first centerless grinders used on commercial work; efficient, yet not economical enough to further the case of the needle bearing. The need for such precise methods of manufacture is evident because the success of bearings of this type depends upon the accuracy and hardness of the bearing elements and the operations by which the hardness is secured. It is easily understandable that small rollers of 56 to 60 Rockwell C would be extremely difficult to produce economically by any method other than centerless grinding.

Inasmuch as the principle of operation of these economical bearings is not as well known as that of other types, it might be well to review the theories of operation before discussing practical applications. The needles, constituting a floating sleeve, are not guided by a cage, but merely are held endwise by shoulders. Their employment should be regarded as an entirely separate problem in design.

European manufacturers and their American licensees consider needle bearings as a combination of a plain and a roller bearing, the effect being such that sliding and rolling action both take place, partial rolling occurring only under the influence of increased bearing pressures or shocks. Under increasing load there is a definite rolling action of those needles in the pressure area, a fraction of the total number of needles, but experiments made in Germany indicate that the speed of the needles about the shaft is approximately half of the speed of the

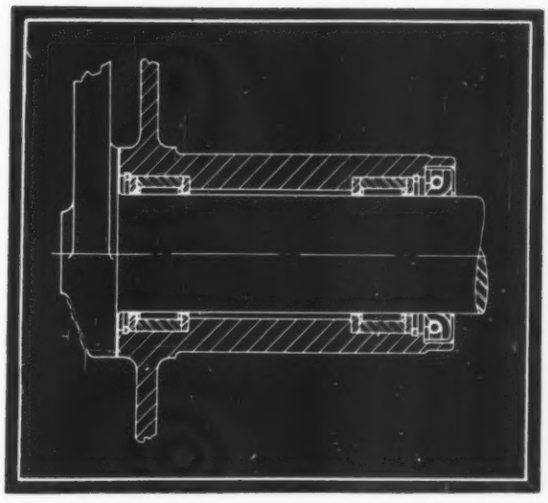


Fig. 1—Needles may be held in place by rings loose in the bore and on the shaft, fastened by snap rings at the ends. Oil seals protect the bearing

Fig. 2—Disassembled bearing from an installation made on a marine engine gudgeon pin. Three rows of needles separated by intermediate rings are used

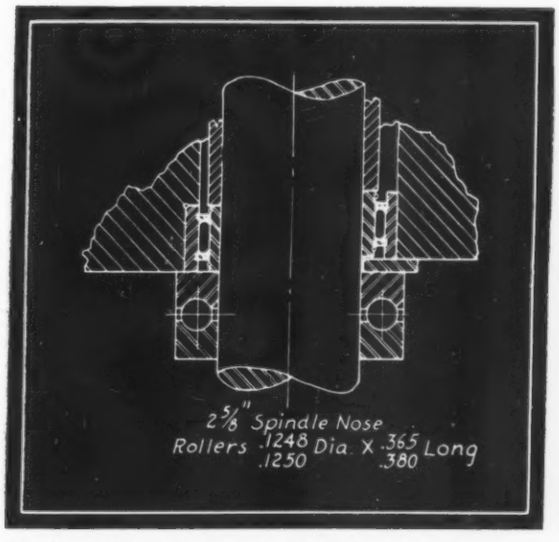


Fig. 3—Self-contained type of bearing is employed in carrying the radial loads on a multiple spindle drill. Needles are especially advantageous here because of the necessity of conserving space

shaft and the speed about their axis is dependent on the load and is less than the linear speed of the inner race. The pressure area is that portion of the bearing where the load is concentrated.

When the condition of equilibrium in the bearing is disturbed, as by a sudden increase in load, the lubricant film between the needle and the raceway is cut. Under the increased friction the needles in the pressure area begin to turn. Direct contact between the needles and the raceway without an intermediate oil film lasts only until the needles begin to turn, for as soon as motion is started oil is carried to the loaded portion of the inner race by the needles turning about their own axes and a film is formed. A satisfactory lubricating film thus is secured, so that in spite of the partial sliding action, premature wear is prevented and a high degree of efficiency obtained.

Several manufacturers do not agree with the foregoing theory of the action of the rollers. Their investigations have indicated that there is a straight rolling action between the inner and outer raceways and a definite rolling action under load of every roller. The ability of the needles to carry high loads without failure is attributed to the high resistance to crushing load of the small rollers, a property which ranges as high as 200,000 pounds per square inch of projected area. The high capacity of the bearings also is attributed to the many lineal inches of contact in the bearing, an unusually high value.

Little Change Required

Needle bearings can be adapted with practically no change in the space required for a plain bearing as they require unusually small space for an antifriction bearing. On account of the high retaining power for the oil and the small centrifugal action of the thin rollers, these bearings may be used advantageously for high speed shafts. They are of special value not only where space is limited but where heavy loads and shock are encountered, and in assisting reciprocating motion in which lubrication problems are most pronounced in plain bearing applications.

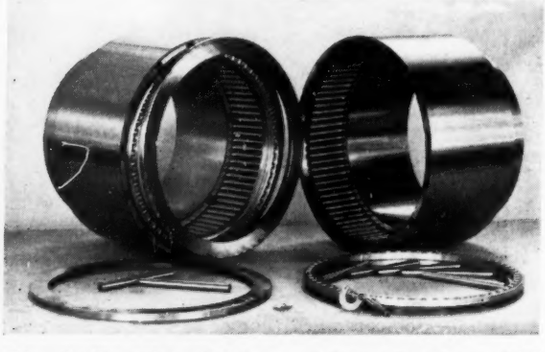


Fig. 4—Experimental type of large bearing which employs full length rollers rather than two rows

Except for a few unusual applications, the length of the needles ranges between three and ten times their diameter for the most satisfactory installations, with the majority well within these limits. Shape of the ends may be spherical, ball, trunnion, conical or chamfered, with the spherical end favored as this shape gives the greatest bearing surface for the same overall length. Trunnion and conical ends are used only in connection with a retainer, this retainer merely functioning during transit and installation to keep the needles, or rollers, from falling out of the outer raceway. The chamfered, spherical or ball end may be used in applications where a self-contained bearing is not needed. The chamfered end has a tendency to score or gall the end rings which the spherical and ball ends do not have. This same condition is experienced in certain applications with the conical end.

Many Applications Developed

Applications of these bearings are now quite numerous and there have been many practical adaptations made which indicate that the needle bearing can be used advantageously for a wide range of purposes. They have been applied for bearings on machines which range from mani-

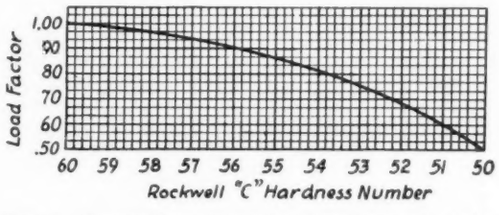


Fig. 5—Correction factor for hardness of shafts

curing machines up to and including the roll neck of a rolling mill.

Fig. 8 shows a valve rocker arm for an airplane engine, and is typical of what can be done in reducing the friction and inertia involved in a valve gear by reducing the size of the bearing. In this particular application the size of the rocker was reduced some 20 per cent which amounts to several pounds spring load on the valve spring. Similar savings have been obtained in cams, crankarms and such parts of machines.

A self-contained type of radial bearing is shown in Fig. 3. This particular application is for use in carrying the radial loads of a multiple spindle drill. In an application of this sort the center distance of the drill heads is of vital importance, and the ability of this type of bearing to adapt itself at practically no expense of space made it specially applicable.

It might appear that this type of bearing is applicable at all bearing points on a machine, especially wherever radial space is at a minimum. This is not the case, however, as needle

bearings will take absolutely no thrust load, a characteristic similar to that possessed by parallel roller bearings. Wherever thrust load is encountered, a thrust bearing should be included in the design to carry this load, as in Fig. 3.

Another type of application where their use is not best practice is where an absolutely rigid mounting of the shaft to hold centers with high precision is demanded. The small amount of play in these bearings is not noticeable during running of the machine and will have no effect in the ordinary installation, but for machines performing precision work of micrometer exactness some other bearing should be employed. It also is a mistake to expect needle bearings to function satisfactorily under conditions of poor workmanship. The raceways should be held truly cylindrical and ground to a close tolerance. The needle bearing is not a makeshift application for designs where poor workmanship is to be used.

Values of "K"

No. Rollers	Value K	No. Rollers	Value K
10	3.2360	38	12.1093
11	3.5495	40	12.7453
12	3.8637	42	13.3813
14	4.4940	44	14.0170
16	5.1258		14.6537
18	5.7587	48	15.2905
20	6.3926	50	15.9261
22	7.0267	55	17.5176
24	7.6611	60	19.1058
26	8.2966	65	20.6977
28	8.9312	70	22.2902
30	9.5666	75	23.8834
32	10.2025	80	25.4712
34	10.8380	85	27.0658
36	11.4745	90	28.6533

There are a number of possible combinations for mounting, any of which will prove satisfactory, but there are a few vital details which must be met on any installation. End clearance on the rollers must be such that the endwise movement of the rollers when they are not actually under radial load is restrained. This clearance at each end of the needles ranges from 0.008 to 0.018 inch. End plates or other surfaces in which the needles abut must be hard in order to withstand the impact and rolling action of the needles along them as they move lightly in a longitudinal direction, again when not under load.

To obtain as high a carrying capacity as possible, both inner and outer raceways should be of sufficient hardness, 60 Rockwell C or higher. It is important, that the needles, also, be hardened and ground; 56 Rockwell C being considered as absolute minimum. The carrying capacity of a total assembly is limited by the minimum hardness of either of the two raceways. A load factor, Fig. 5, must be used wherever the hardness of either raceway is less than 58-60 Rockwell C. Where design considerations make it advisable, separate raceways can be dispensed with and needles placed directly in the hardened and ground bore and on the hardened and ground shaft.

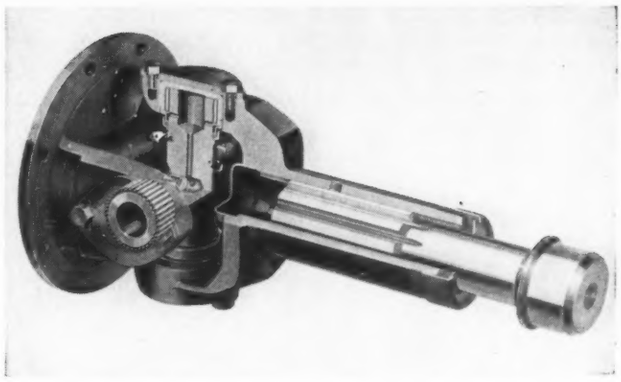


Fig. 6—End plate in this universal joint application extends over the needles on both sides of the shaft

Diameter of the shaft, diameter of bore and the number of needles to be inserted are determined either by conditions of design or by simply solved formulas, given later as developed by a manufacturer of the needles in this country and based on roller bearing formulas. Provision must be made that the peripheral space between the inner and outer race is not filled completely by the needles. To secure satisfactory running conditions, sufficient radial play also must be provided. Recommended values for such circumferential clearance are 0.0001 inch per roller, minimum, up to the diameter of one roller as a maximum.

Flanges on Same Member

The locating or guiding flanges at each end of the rollers should be located on the same member, that is both should be on the outer raceway or both on the inner raceway. Or one of these end plates, or both may be integral with the raceway. If one is integral, the other end plate may be a loose piece which is loose in the bore and over the shaft. If one is integral, the other end plate may be a loose piece which is loose in the bore and over the shaft. If both end plates are loose pieces, they should be held into place by co-operating parts of the machine or snap rings, Fig. 1. The plates may be a mild press fit, or the raceway may be a straight piece into grooves on which the end plates are snapped. A further refinement may be to place the needles in a groove of proper dimension recessed in the shaft or in the inner or outer housings.

Lubrication is as essential for this type as for any bearing, but a needle bearing has the ability to carry its lubricant along with it, through its turning action automatically replenishing lubricant cut away from its surface. The surface area of this type is considerably greater, therefore the unbroken oil film is greater under average conditions.

If automatic lubrication is dictated by the par-

ticular application, the oil is supplied through the inner or outer member. Oil is the most suitable lubricant especially for higher speeds. On machine tools simple oil or grease lubrication is sufficient, while high speed engines should have pressure lubrication.

The approximate number of needles is found

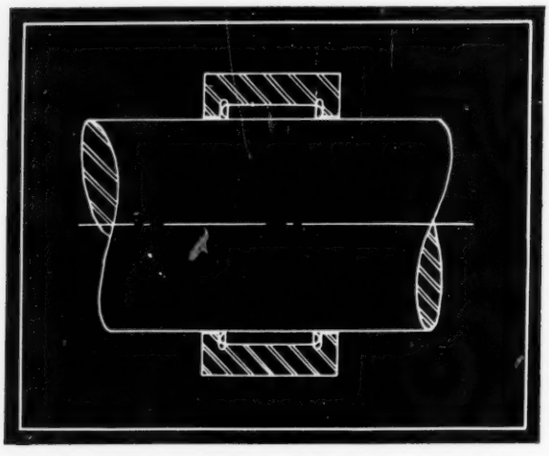


Fig. 7—A single part may be used to retain the needles which bear directly on the shaft

by the following formula, the nearest whole number being used.

$$N\ (approx.) = \frac{D\ (approx.) + d \times \pi}{d} \quad \text{..... (1)}$$

where

N = number of rollers
D = diameter of shaft or outer diameter of raceway in inches (determined by previous steps in the design)
d = diameter of rollers in inches (roller size as selected being governed by space available and diameter-length ratio)

Having the approximate number of rollers use the value of K from the accompanying table for this number of needles and substitute in formula (2) to determine the pitch diameter, PD.

$$PD = \frac{K \times d \times \pi + CC}{\pi} \quad \text{..... (2)}$$

where CC is circumferential clearance selected under the limits noted in the foregoing.

Subtract the roller diameter from the pitch diameter to obtain the shaft or inner raceway diameter D. This diameter should be plus nothing minus the tolerance used in manufacturing (0.0005 inch for sizes up to 4 inches).

Clearance Is Necessary

The proper diametral clearance, dc, is of vital importance to the proper functioning of the complete bearing. On shafts up to 2 inches this value must be held from 0.0005 to 0.0015 inch, a figure which does not include tolerance of the rollers themselves which varies from a total of 0.0004 to 0.0008 but does include the tolerances of the inner and outer raceways. In making any calculations the high limit of the roller should be used. On shafts from 2 to 4 inches diameter the value of dc must be held from 0.001 to 0.002 inch and for shafts from 4 to 6 inches diameter the value should be from 0.0015 to 0.0025 inch. Where distortion of the raceways occurs due to press fits or other reasons, allowances must be made in the value of dc.

The bore or inside diameter of the outer raceway is found by adding the values of dc, d and PD. To this value a manufacturing tolerance must be added (0.0005 inch for sizes up to 4 inches).

In many cases several external factors or a combination of them may result in a bearing being able to carry only a small percentage of its rated capacity, while in some cases loads several times the rated capacity can be carried. Most of these factors can be controlled, but strict attention to detail is necessary for efficient and continued satisfactory operation.

The rated safe load in pounds R, may be computed by

$$R = \frac{N \times L \times d \times 11{,}250}{\sqrt[9]{S}} \quad \text{..... (3)}$$

where

N = number of rollers for a full complement bearings as determined
L = effective length of one roller or row of rollers in inches (less chamfers radii, etc.) Recommended tolerance on length is normal size minus 0.005 to 0.015 inch
S = speed of shaft in R. P. M.

This formula should be used in connection

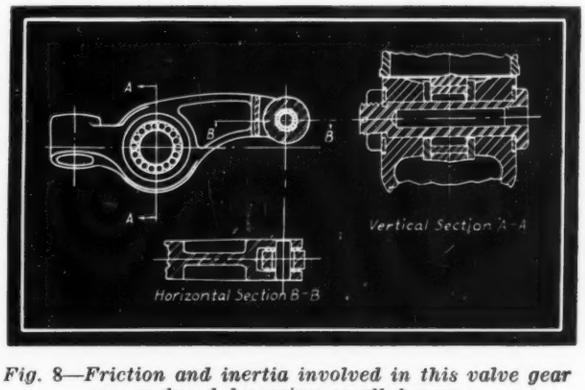
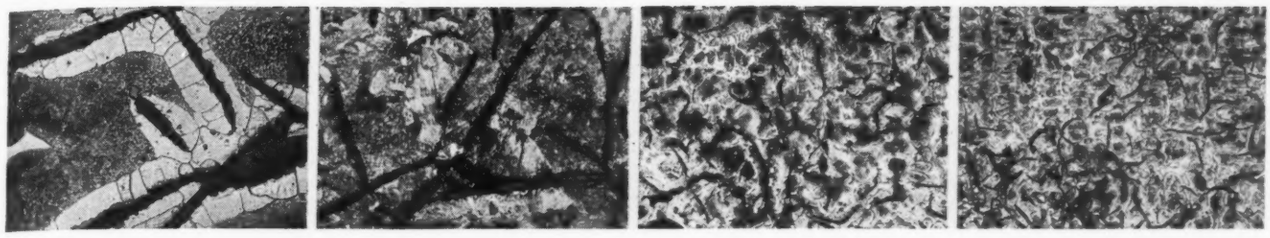


Fig. 8—Friction and inertia involved in this valve gear was reduced by using small bearings

with a hardness load factor as found in Fig. 5. Length of the raceways to accommodate the rollers should be of nominal size plus 0.10 plus 0.025 inch to give the clearance noted in the foregoing.

For their courtesy in supplying illustrations for use with this article MACHINE DESIGN acknowledges the assistance of Bantam Ball Bearing Co., Figs. 3, 4 and 8; Norma-Hoffmann Bearings

(Concluded on Page 43)



Etched specimens of cast iron containing extremely coarse, coarse, moderately fine and fine graphite inclusions

How Alloying Elements Affect Performance

MAXIMUM service with minimum wear is the aim of every designer of machinery, an aim that is governed principally by the proper selection of the materials which go into the machine. An exact knowledge of how the materials used will react in service, brought out in this article translated by G. K. Herzog, Electro Metallurgical Co., is of inestimable value.

FACTORS affecting wear or abrasion resistance of cast iron have been the subject of considerable study both in this country and abroad. The importance of this subject is universally recognized and although several investigations have been made, independent investigators frequently do not agree in their conclusions. Many difficulties encountered in the study of this problem have led to varied opinions as to the effect of composition and structure on the abrasion resistance of cast iron, a problem of considerable importance when designing a part.

Recently there appeared in Germany the results of a comprehensive study of the subject ("Further Investigations on the Effect of Composition and Structure on the Abrasion of Cast Iron," by Dr. Ing. Th. Klingenstein, in *Mitt. Forsch, Anst. G. H. H. Konzern,* Vol 1, No. 4) and it is thought that an abstract of the experimental procedure, results and conclusions of the author will be of interest.

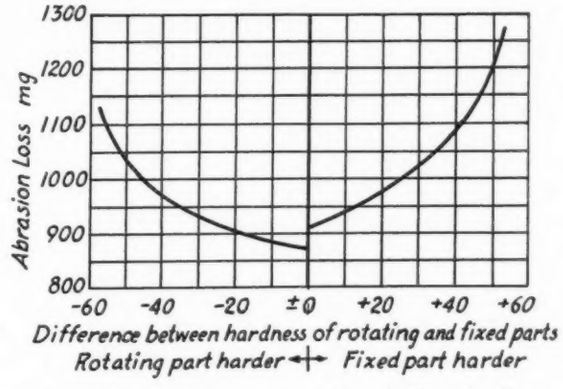


Fig. 1—Least abrasion is with similar hardness

Starting with the fact that in studying the wear of cast iron the moving piece and the stationary piece must be considered simultaneously, a testing apparatus was constructed by rebuilding a friction-driven drill press. The movable part of the test piece consisted of a cylindrical rod set in a special socket connected to the spindle of the press, while the stationary part was a rectangular piece attached to the table; so that it was possible to have each sample of a different grade of cast iron. The end of the rod which is rotated is pressed against the fixed sample and is thereby worn off; simultaneously it buries itself more or less deeply into the stationary test piece. The apparatus was so designed that any desired load, to give a pressure P between the two specimens, could be applied to the rotating part.

Describes Test Procedure

A number of preliminary tests were run in order to determine the most satisfactory value of the pressure P and the rotating speed n of the drill part to give the most consistent results. In all the following tests a pressure of 24 kilograms per square centimeter (340 pounds per square

inch) and a speed of 325 revolutions per minute were adopted as standard. Using this pressure and speed, a number of tests were made for periods of 10 minutes each. The dust formed during the abrasion tests was retained, exactly as in actual operations where the small metallic particles contained in the oil contribute to the wearing away of the machine part. However, these tests were conducted dry, that is, without the use of lubricants. Three varieties of cast iron all of which were cast from cupola iron were used in the tests. Variety I was a soft machinery casting, Variety II a cylinder cast iron for relatively thin-walled castings, and Variety III a cylinder cast iron for relatively heavy-walled castings. The composition of the series of irons used is shown in Table I. The cylindrical rods all had a diameter of 10 mm. (0.4 in.) and a length of about 50 to 70 mm. (2 to 2.8 in.). The stationary test pieces measured 30 x 30 x 10 mm. (1.2 x 1.2 x 0.4 in.). One rod cast in green sand and one cast in dry sand of each variety of cast iron were tested against each of the twelve samples. In the tables those samples cast in dry sand are designated *D* and those cast in green sand are designated *G*.

Abrasion Losses Determined

Table II shows the abrasion losses when Variety I was rotated against Varieties I, II and III. The last two columns of this table give a comparison of the abrasion losses with difference in hardness between the rod and stationary test piece. These figures, together with those determined for a case where the rotating part was harder than the stationary part, are shown graphically in Fig. 1, and indicate that the least abrasion loss is obtained when two test pieces are of similar hardness.

TABLE I

Analyses of the Cast Irons

			Brinell	Per Cent						
No.	Variety	Mold	H'dness	Total C	Graph.	Comb. C	Si	Mn	P	S
D 1	II	D	226	3.15	2.54	0.61	1.80	0.99	0.43	0.085
D 2	II	G	230	3.31	2.52	0.79	1.80	1.02	0.42	0.055
D 3	II	G	234	3.21	2.50	0.71	1.69	0.99	0.41	0.109
D 4	II	D	226	3.37	2.46	0.91	1.68	0.99	0.40	0.097
D 5	III	D	230	3.35	2.58	0.77	1.47	1.02	0.42	0.089
D 6	III	G	234	3.35	2.56	0.77	1.46	1.02	0.38	0.093
D 7	III	D	230	3.30	2.52	0.78	1.53	1.12	0.34	0.097
D 8	III	G	230	3.28	2.48	0.80	1.53	1.12	0.34	0.097
D 9	I	D	186	3 56	2.87	0.69	2.25	0.78	0.34	0.089
D 10	I	G	188	3.48	2.94	0.54	2.24	0.76	0.38	0.077
D 11	I	D	178	3.48	2.96	0 52	2.29	0.76	0 33	0.073
D 12	I	G	180	3.40	2.90	0.50	2 31	0.76	0.34	0.068

The relation between hardness, when both rotating part and fixed part are of similar hardness, and the abrasion loss is shown in Fig. 2. This curve indicates clearly that with increasing hardness the abrasion loss is lowered.

The ever recurring question of how the use of chromium-nickel alloy cast iron affects loss by abrasion made it necessary to include in the scope of this work the question: How do the individual alloying constituents of gray cast iron, i.e., silicon, manganese, phosphorus, sulphur, carbon, chromium and chromium-nickel affect abrasion? A series of experiments in which increasing amounts of these elements were added was undertaken on exactly the same basis as those already described. The results are shown in Fig. 3. The values in each case show the abrasion loss which was obtained when the two parts working against each other were made from the same sample. In the main series of experiments it had been shown that under these conditions the loss was the lowest.

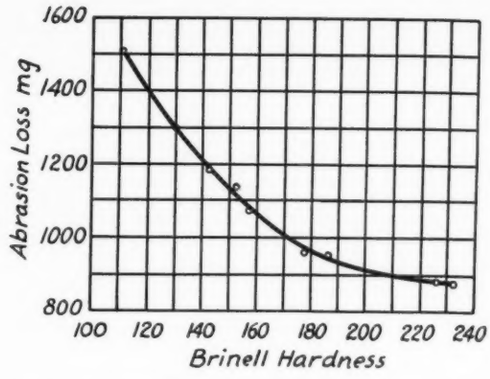


Fig. 2—Increasing hardness lessens abrasion

These curves indicate that the greatest effect on the abrasion resistance of cast iron is exerted by chromium and by phosphorus, chromium-nickel having somewhat less effect. An increase in manganese content has a slightly favorable effect on abrasion loss, while the silicon, as was to be expected, caused an increase in the abrasion loss with increase of silicon.

The conclusions to be drawn from this work may be summarized as follows:

When cast iron works on cast iron in such a manner that one of the machine parts is fixed and the other moves over it (for instance, cylinders and pistons in motors, or bed and slide in a machine), then it holds that: The absolute hardness is only a relative measure for the abrasion resistance of a casting. The difference between the hardness of the stationary and the moving part is the determining factor for the abrasion loss in the case of a high test cast iron. The abrasion loss is the least when the difference in

hardness is zero. The conditions for a low abrasion loss are better when the moving part is harder than the stationary part than when the reverse is the case.

Effect of Carbon and Silicon

The presence of graphite in high test cast iron in the form of long thin veins reduces the abrasion loss. Beyond a certain limit the fineness of graphite veins has no further favorable effect.

The abrasion loss is increased by the presence of graphite in coarse, thick veins.

The abrasion loss increases with increasing silicon content.

Effect of Manganese

An increasing manganese content results in a small reduction in the abrasion loss.

Effect of Phosphorus

Phosphorus has a decided effect in lowering the abrasion loss. However, the physical properties, particularly the deflection, are reduced considerably with increasing phosphorus content.

Effect of Sulphur

No tests were conducted on sulphur as the foundryman always strives to eliminate this undesirable impurity.

Effect of Nickel

Nickel alone has but little effect on the abrasion resistance of cast iron.

Effect of Chromium

Chromium hardens the ground mass and refines the structure.

The resistance to abrasion increases with a chromium content of 0.4 per cent or over and at 0.7 per cent chromium it is increased by 25 per cent.

Effect of Chromium-Nickel

Chromium-nickel increase the wear resistance considerably through their combined effects.

Effect of Higher Temperatures on Wear

No change in wear could be shown for temperatures up to 250 degrees Cent. The samples containing unusually high phosphorus content were, however, an exception to this rule. In this case the abrasion loss at 250 degrees Cent. was 25 per cent higher than at a normal temperature of 20 degrees Cent.

Effect of Surface Finish

Cast irons having a hardness of 220 brinell require a better degree of finish than those of a lower hardness. In the case of cast irons having a hardness of 180 brinell, a plastic deformation of the surface crystals may be brought about by allowing two pieces to work against each other and thus obtaining a mirror-like surface.

The grains of a ground mass having a hardness of about 220 brinell cannot be deformed to the same degree as the grains of a ground mass of lower hardness. For this reason the surface of machine parts having this hardness must be smoothed by mechanical means such as grinding, lapping or honing.

The higher the grade of a gray iron the better must be the degree of finish.

For the reasons given above attention must here be called to the importance of allowing pistons to wear themselves in, because this wearing in is nothing more than a process for smoothing the surface.

TABLE II

Resulting Abrasion Losses

Stationary Portion			Abrasion Loss		Rotating Portion			Abrasion Loss	Total Abrasion Loss	Difference in Brinell Hardness
			Brinell Hardness	G_1			Brinell Hardness	G_2	G_1+G_2	
No.	Var	Mold		mg.	No.	Var		mg.	mg.	
D 1	II	D	226	631	D 12	I	180	509	1140	+46
D 2	II	G	230	722	D 12	I	180	523	1245	+50
D 3	II	G	234	658	D 12	I	180	495	1153	+54
D 4	II	D	226	709	D 12	I	180	522	1231	+46
D 5	III	D	230	536	D 12	I	180	501	1037	+50
D 6	III	G	234	572	D 12	I	180	555	1127	+54
D 7	III	D	230	661	D 12	I	180	625	1286	+50
D 8	III	G	230	649	D 12	I	180	602	1251	+50
D 9	I	D	186	457	D 12	I	180	500	957	+ 6
D 10	I	G	188	492	D 12	I	180	469	961	+ 8
D 11	I	D	178	453	D 12	I	180	464	917	−2
D 12	I	G	180	450	D 12	I	180	490	940	0

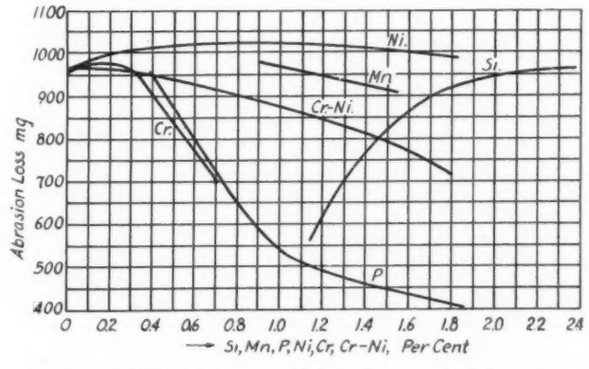


Fig. 3—Effect of alloy additions on abrasion loss

Must Design Better Machines!

WRITTEN in letters a mile high is the warning to manufacturers that labor rates are going to go higher than they have ever gone in this country. That is right and we hope they do. It is a challenge to the engineering ability of the country. It means that more and better machines must be designed . . . . Production per kilo man hour will have to increase enormously to meet the new world conditions. Six months ago such a statement would have sounded crazy. Six months from now, even the bankers will know it is true. The machine age is just beginning.—R. E. Kinkead in *Industry and Welding.*

MACHINE DESIGN

L. E. JERMY, EDITOR
ALLEN F. CLARK
HAROLD B. VEITH
F. H. BURGESS

Short Hours, High Wages Will Call for More Efficient Machines

MANUFACTURERS of machinery and parts have been concerned with the apparent policy of the national recovery administration to discourage the introduction of "labor saving" equipment. The cotton textile code carries restrictions on the hours machinery may be operated. The steel code bans the installation of new steelmaking capacity. General Johnson, while stating that "necessary installation of new equipment should go forward," makes this reservation: "I do think that for a short period it would be wise to not emphasize the installation of machinery that tends to further reduce the field of employment."

These signs indicate that the government wishes to forego some of the advantages of machines—at least in the early stages of recovery. Apparently it ignores the fact that proper utilization of machines would provide more jobs in the plants of machine and parts manufacturers.

Fortunately the situation probably will right itself as the nation jumps farther into the recovery program. In standardizing hours and wages and discouraging the addition of new capacity, the government virtually makes efficiency, instead of price, the chief weapon of competition.

This means that employers, having hired more workers and raised wages, will try to offset increased costs by greater efficiency. Thus a new demand for "labor aiding" devices will be created.

Manufacturers are awake to this necessity. A number of machinery companies already are engaged on designs for "aiding" labor. As this trend develops and expands, the machinery industry will assume its rightful place in the recovery program.

• • •

Credit Where It's Due

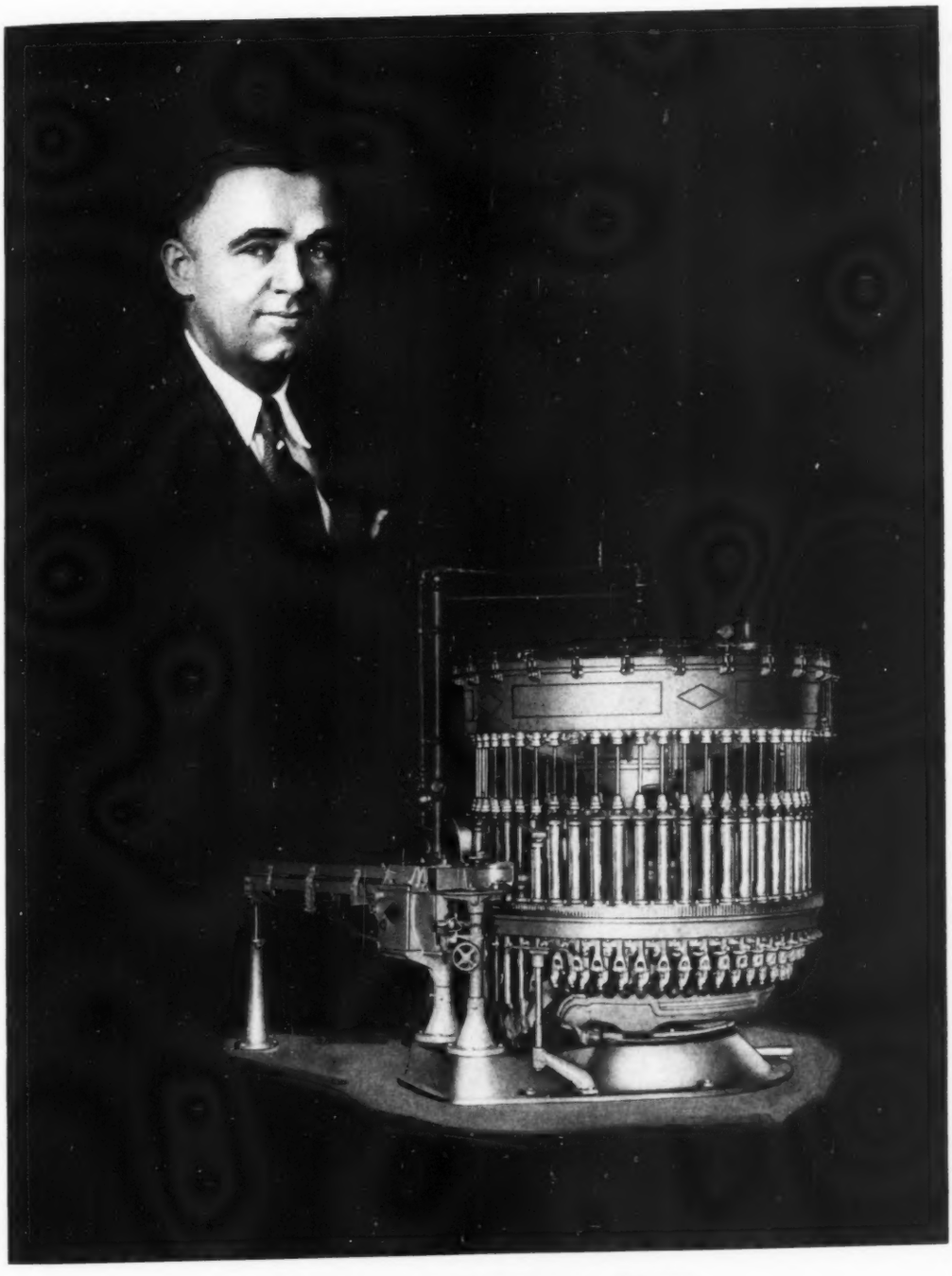
ENGINEERS have the opportunity of reading, in various technical journals, information on new machines as they are placed on the market. Rarely, however, are any details included regarding the men behind these projects. Full credit is given—rightly—to the company, but a measure of that credit surely is due the man or men who have played a major part in bringing to a successful conclusion the development of the new units.

For this reason MACHINE DESIGN inaugurates a new department in the current issue, commencing on the two following pages. This will be a series depicting the introduction of newly-developed machines and the men responsible for their design. It is believed the high-spotting of the lives of these men will prove not only interesting but will serve to bring merited attention to their work.

MEN

and Their

MACHINES



J. KANTOR AND HIS BOTTLE FILLER

Men and Their Machines

Brewing Industry

SEVENTEEN years with one company! Therein lies the key to one engineer's successful career in designing. We refer to J. Kantor, whose Monarch bottle filling machine won the acclaim of the brewing industry when beer came back. If asked why he has remained with the Liquid Carbonic Corp., Chicago, since his graduation from the University of Illinois in 1916 he will tell you that the diversification of brewing machinery design leaves no room for monotony . . . . continuous development has claimed his concentrated attention and interest.

Other reasons make his work stimulating. There is a dearth of books and publications on this type of equipment. That throws him on his ingenuity; makes him always on the alert for ideas that often occur to him while studying technical works, to which he confines his reading.

From early boyhood Mr. Kantor was technically inclined. Not fond of sports, he was attracted by mechanical devices. Early aptitude in woodworking and repairing small machines is reflected in his succeeding years (even yet he repairs his own car as a hobby). As might be expected, this Chicago-born lad derived a great deal of pleasure during his youthful excursions to the country in "taking time out" to observe the operation of agricultural machinery.

Time came to go to college and Kantor naturally matriculated in the college of engineering. Upon completion he entered the engineering department of the Liquid Carbonic company. Three years later he was chief draftsman and seven years after that chief engineer, which position he now holds at the age of 43. When the revived brewing industry created a market for an improved bottler last spring, Mr. Kantor's design was readily adaptable to meet the requirements. Some of the many problems he has solved were discussed in MACHINE DESIGN (April, p. 11). Refinement to combat the tendency of beer to foam when agitated was an important achievement in this new unit.

Despite Mr. Kantor's strong devotion to design he is an accomplished musician, playing the cornet. It would be difficult to say in which form of art, music or design, he has excelled. In both, his accomplishments are outstanding.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Welcomes Letters or Solutions to Problems Suitable for Publication

Solving Irregular Area Problems

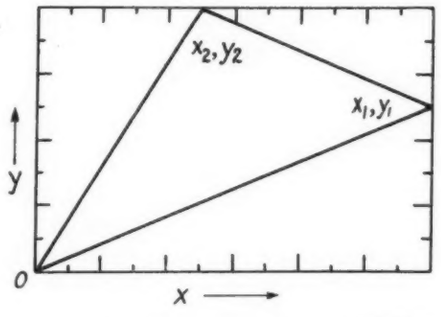
To the Editor:

THE job of determining areas of oblique triangles and other irregular figures is often bothersome for designers, but this can be done simply and accurately by determinants by merely finding the co-ordinate points of the vertices. This method is particularly useful for bending moment diagrams in deflection calculations, weight computations, areas of irregularly shaped plates, etc., as it can be computed without scaling and computing many hypotenuses.

Consider the oblique triangle shown in the first illustration. When the origin, O, contains a vertex, the determinant is simple. Letting A denote area, in square units, we have

$$A = \tfrac{1}{2} \begin{vmatrix} x_1 & y_1 \\ x_2 & y_2 \end{vmatrix}$$

In developing, we subtract the products on the



Area of oblique triangle is calculated easily by use of determinants

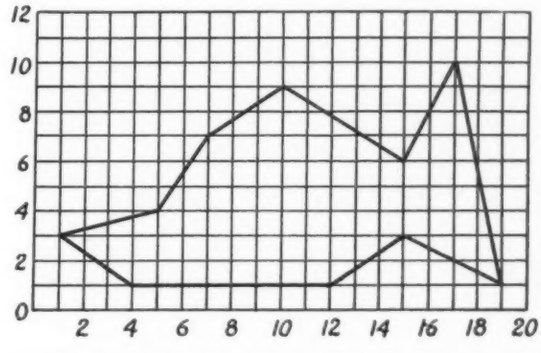
diagonal pointing up to the right from the products on the diagonal pointing up to the left, giving

$$A = \tfrac{1}{2} (x_1y_2 - x_2y_1)$$

Thus, in this simple way, the area is obtained without possible errors of scaling, and without resolving into right triangles.

In the more generalized case, when no vertex is placed at O, a third order determinant is obtained, which leads into the following facile and accurate method of finding the area of a figure bounded by any number of straight lines, second illustration. Curves can be resolved into equivalent straight lines.

To find this area, form two columns: the first beginning with x_1, x_2, x_3,.....x_n, then another beginning with y_2, y_3, y_4.....y_n, y_1 which are additive products. Form two more, which are subtractive, the first beginning with y_1, y_2, y_3.....y_n,



Method may be applied to more complicated figures by determining the co-ordinates of the vertices

the second with x_2, x_3, x_4.....x_n, x_1, all as shown. Add the sum of all with regard to their signs, divide by 2, and the result is the area.

$x_1y_2 - y_1x_2 =$
$x_2y_3 - y_2x_3 =$
$x_3y_4 - y_3x_4 =$
$x_4y_n - y_4x_n =$
$x_ny_1 - y_nx_1 =$

$+ \Sigma =$

In the second illustration, we have

x		y		y		x		+	−
1	×	1	−	3	×	4	=		11
4	×	1	−	1	×	12	=		8
12	×	3	−	1	×	15	=	21	
15	×	1	−	3	×	19	=		42
19	×	10	−	1	×	17	=	173	
17	×	6	−	10	×	15	=		48
15	×	9	−	6	×	10	=	75	
10	×	7	−	9	×	7	=	7	
7	×	4	−	7	×	5	=		7
5	×	3	−	4	×	1	=	11	

$+287 - 116 = 171$

$\tfrac{1}{2} \times 171 = 85.5$ *square units*

The leading principles of the above were given

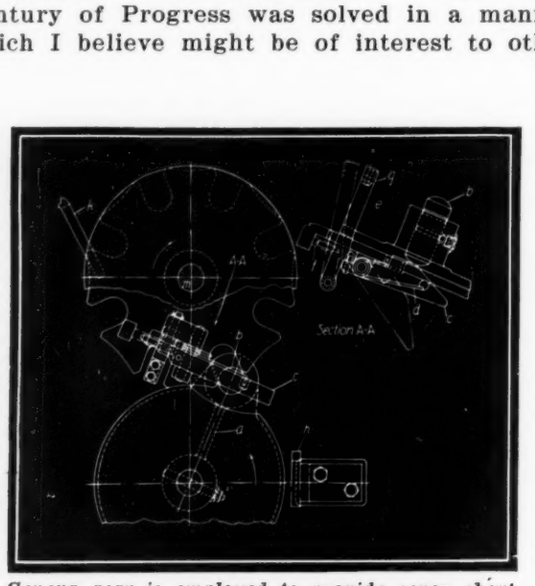
to the writer by a Russian mathematician and have been largely used by myself to find specific pressures on water turbine vanes.

—JOHN S. CARPENTER,
York, Pa.

Securing Irregular Movements

To the Editor:

A PROBLEM of arranging irregular stops which recently came up in the design of an exhibit of the department of labor at A Century of Progress was solved in a manner which I believe might be of interest to other designers. This device, shown in the accompanying illustration, is to revolve an octagonal drum mounted between two flanges on shaft *m*. The drum has reading matter on each face. One of these faces had to be retained in a stationary position for twice the time of the other seven faces. To accomplish this, we contrived the following mechanism.



Geneva gear is employed to provide seven short stops and an eighth stop of twice the time

In order to lock the drum after each turn, and time it properly, we utilized the simple expedient of incorporating a geneva gear motion. The driving arm *a* is mounted on a vertical shaft and driven from a motor through a conventional bevel gear arrangement. Driving pin *b*, which in most such mechanisms is retained integral with the driving arm, was in this instance designed to slide vertically in the boss of the driving arm, being retained in two positions by a spring and ball tension coinciding with two grooves cut in the pin.

Mounted on the geneva plate is latch *c* held in a downward position by coil spring *d*. The latch is arranged with a cam face located in a vertical plane substantially tangent to the path of travel of the pin *b* and at right angles to the point where the pin enters the slots on the geneva wheel.

Another latch *e* is pivotally mounted and has on it a step coacting with an extension on latch *c*. Vertically suspended, latch *e* is held in position by compression spring *f*. The cam portion of latch *c*, when this latch is held by the step on latch *e*, coacts with pin *b* to force this pin to slide downward while driving arm *a* continues to rotate. The height of the cam on latch *c* is such as to cause the pin *b* to assume a distance equal to the thickness of the geneva wheel, and as rotation of arm *a* continues it will be apparent that the wheel will not be revolved.

However, in causing pin *b* to slide out of mesh with the first slot, the bottom part of the pin extends below the boss on driving arm *a*, As rotation continues this portion of the pin will strike on cam *g* causing latch *e* to swing out of engagement with latch *c*, the latter snapping upward through the medium of spring *d*. Arm *a* continuing in its rotation will cause pin *b* to be pushed back into normal position by means of cam *h*. Inasmuch as the cam of latch *c* is now no longer in operative position at the first slot, the pin will cause the rotation of the geneva wheel in a normal manner and thereafter will operate for seven positions in uniform succession. As the wheel revolves, latch *c* will come in contact with cam *k* so that it will be forced down into its normal latched position. On the eighth turn of the geneva, cam surface *c* will be in position and will repeat the operation of moving pin *b* out of engagement and providing a double stop.

It will be apparent that this principle may be applied on one or more stations.

—JOSEPH S. PECKER,
Philadelphia

Chart Shows Steel Compositions

NICKEL alloy steel compositions and treatments required to develop yield points up to 175,000 pounds per square inch in section sizes varying from 1 to 12 inches are shown at a glance on a new circular chart developed by International Nickel Co. Inc., New York. The figures given are based on numerous tests, and may be used as a general guide to the selection of steels for bars, shafting and forgings of single shape. In the use of the chart the required size (diameter) and yield point, or the next largest size and yield point, are selected from the values around the edge. When an arrow on the face of the circular guide piece is brought to this point, the recommended steel, treatment and approximate properties are shown through windows in the face of the guide piece. Chemical compositions of the steels referred to are listed on the back of the chart.

Value of Patent Depends upon Claims

(*Concluded from Page* 16)

amend the claims by inserting limiting provisions that are present in the inventor's device but are not present in the devices of the prior art. This mean that the amended claims, by reason of the added limiting provisions, do not now "read on" the devices of the prior art. If the examiner cannot find any prior art to meet the amended claims, the claims are allowable and a patent may be issued.

The inventor should exercise great care when amending his claims, because in an endeavor to draft his claims to avoid clearly the prior art he may make unnecessary limitations that so restrict the scope of his claims as not to catch infringers. When once a limitation is made in a claim and a patent is allowed with such a restricted feature, the inventor cannot enlarge the scope of his restricted claim by interpreting it as if the limiting provisions were not present. Hence, an inventor is bound by the limiting features of his amended claims.

Accordingly, C could obtain a patent on his knife so long as his claims did not "read on" A's or B's knife. One of C's claims might be:

> A knife comprising a handle having a recess, a blade having a cutting edge pivoted to said handle and disposed to move into and out of said recess, *and a spring coacting with said blade to hold it in position.*

Such a claim would even prevent A or B, as well as others, from manufacturing, selling or using a knife having a coacting spring to hold the blade in its respective positions. This being the singular feature that gves C's knife commercial merit, he would be in a good position to bargain with A for a cross-license agreement to the benefit of both parties.

Each claim in a patent should define a complete invention irrespective of any other claim in the patent application. It is not, however, considered good practice to multiply the number of claims unnecessarily, with variant language. Nor is it considered good practice to write claims in vague phraseology with the idea that vagueness allows any one of several elastic interpretations, so that the inventor may stretch the meaning of his claim to catch infringers. The reason that such practice is bad is that the inventor, while attempting to stretch the meaning of his claim to catch infringers, may stretch it to the breaking point of including prior inventions in which case the claim would be considered invalid.

Claims must not be drawn to a mere use of the device, nor to a mere result, as the result is the aim of the invention and not the invention itself. Also, the claims must state what the invention is, and not what it is not. Thus, a claim which includes as one of its elements "—a *hole*—" is inaccurate, for a *hole* is the absence of something. However, the structure around the hole may be claimed as an element of a claim. There are many other things to be considered while writing patent claims, but the foregoing are set forth merely to give the reader a few of the many things to look out for when analyzing the soundness of the claims of a patent.

The drawings must be executed in accordance with the rules of the Patent Office and must show every feature of the invention covered by the claims, Fig. 5. The drawings may supplement an indefinite description, but they cannot make up for a complete absence of the description. In view of the fact that it is not invention to change the size or degree of a thing, or to substitute superior for inferior materials, the dimensions or materials used do not have to be given in the drawings. However, if the size of parts, the kind of materials, or the proportions of ingredients are essential to the understanding of the invention, they must be given.

An article on this subject published in a previous issue of MACHINE DESIGN is:

"Careful Research Obviates Patent Pitfalls," by George V. Woodling, March, 1933, p. 25.

Needle Bearings—Unique Machine Elements

(*Concluded from Page* 34)

Corp., Figs. 1 and 7; Nadellager G.m.b.H. through E. Gruenfeldt in this country, Fig. 2; and Spicer Mfg. Co., Fig. 6.

Articles on this and allied subjects published in previous issues of MACHINE DESIGN include:

"Effective Methods of Lubricating Antifriction Bearings," by Harry R. Reynolds, Oct., 1929, p. 32, also by Allen F. Brewer, Jan., 1930, p. 24, and J. S. Pierson, Jan., 1930, p. 45.

"Safety of Bearings Is Determined by Oil Flm Thickness," by G. B. Karelitz, Feb., 1930, p. 46.

"Employing Antifriction Bearings in Heavy Machinery," by John D. Rauch, June, 1930, p. 39.

"Designing Spindles and Mountings for Extreme Speeds," by F. A. Firnhaber, Aug., 1930, p. 35. Sept., 1930, p. 35.

"Meeting High Pressure Problems in Journal Bearings," by A. G. M. Michell, Sept., 1930, p. 46.

"Analyzing Types of Bearings Used in Machines," by J. A. Hoff, Oct., 1930, p. 46.

"Mounting Heavy Duty Roller Bearings," by S. M. Weckstein, Dec., 1930, p. 34.

"Defects in Design and Tooling of Bearings," by C. H. Bierbaum, March, 1931, p. 37.

"Bearings Operate Efficiently at 500 Degrees Fahr." June, 1931, p. 51.

"Will Needle Bearings Gain Headway?" April, 1931, p. 34, also by R. A. Perrett, June, 1931, p. 54, and by C. G Williams, Sept., 1931, p. 55.

"Preloaded Antifriction Bearings Insure Extreme Accuracy and Ridgidity," by Thomas Barish, Oct., 1931, p. 36.

"Shaft Deflection and Its Influence on Bearing Design," by H. F. Shepherd, Jan., 1932, p. 42.

"Alloy Steel Solves Bearing Mounting Problem," by D. L. Holbrook, April, 1932, p. 33.

"Calculating Spindle Loads and Deflections," by James A. Hall, May, 1932, p. 38.

"Oil Grooves in Bearings," by James I. Clower, Aug., 1932, p. 39.

"Babbitt or Bronze?" by C. H. Bierbaum, Sept., 1932, p. 25.

"Reducing Friction in Antifriction Bearings," by Thomas Barish, Nov., 1932, p. 29.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

Machinery Institute Formed to Promote Interests of Manufacturers

FORMATION of the Machinery and Allied Products institute marks a forward step in trade association activity. The new group, representing as it does through its present member organizations, some of the largest corporations in the manufacture of machinery parts and allied products, is in a position to work with the National Industrial Recovery administration in a unified way in accordance with the expressed wish of the administrator of the act.

Office of the institute is located in Chicago and its president is John W. O'Leary, president of A. J. O'Leary & Sons, makers of drop forgings. One of the objects of the organization is "to promote the common interests of the manufacturers of machinery and parts thereof and allied products in manufacturing, engineering, marketing, safety, transportation and other industrial problems."

* * *

Marburg Lecturer Throws New Light on Fatigue Limit of Metals

AT THE recent annual meeting of the American Society for Testing Materials in Chicago, Dr. Herbert J. Gough, superintendent of the engineering division, British National Physical Laboratory, delivered the 1933 Marburg lecture. Data he gave was of extreme importance to those concerned with the design of machinery.

Dr. Gough, whose picture and biographical sketch appeared on pages 42 and 43 of the July issue, for some 10 years has been studying the strength of specimens of metal so prepared that each specimen consists of a single large grain. He has found that as the specimen is repeatedly loaded the crystal breaks up into a large number of little "crystallites," and he thinks that the paths of the electrons or atoms around the nuclei may be affected. The first effect of this action is to strengthen the material, but if it goes on long enough, in the breaking-up process of crystals, atoms at critical points actually seem to be torn apart, and if this process continues a spreading crack results. This, he believes, is the beginning of the sudden, disastrous failure popularly known as "fatigue of metals."

* * *

Recent Showing of Three-Wheel Vehicle Revives Interest in Trend

WILL the three-wheel vehicle regain its popularity? This question naturally will arise in the minds of many who inspect the Dymaxion car at the Century of Progress exposition. Before it was taken to Chicago the development was exhibited at the laboratory of the 4D Co. in Bridgeport, Conn., where it was built. This type of auto was popular some years ago in England.

The vehicle has two wheels abreast and one wheel astern, the two front wheels carrying 75 per cent of the total weight and serving as tractors and brakes. The single stern wheel acts as the rudder. This wheel arrangement is said to make feasible a true streamlined shell without increased road path and affords increased kinetic stability. Air resistance, it is claimed, is approximately one-fourth that of the standard sedan.

* * *

New System of Brewing Beer Speeds Production of Beverage

DEVELOPMENT of a system whereby beer can be produced without the conventional beer cellars in about two weeks instead of the customary two or three months, has aroused the interest of brewery equipment engineers. This innovation in brewing was developed by Dr. L. Nathan, Zurich, Switzerland, and was described at the recent meeting of the American

Society of Refrigerating Engineers in Chicago. The Nathan system does not require any changes in the brewhouse but is concerned primarily with changes in the wort cooling and fermentation.

* * *

Plans Are Laid to Establish Viscosity Classification System for Oil

WIDE interest throughout industry is promised for the new program of establishing a viscosity classification system for industrial lubricants. This subject was brought up for discussion at the American Society of Mechanical Engineers lubrication meeting held at Pennsylvania State college recently. A gathering of over 100 representatives of users and manufacturers of lubricants unanimously recommended that the American Standards association committee be organized to develop a simple significant and readily interpretable system of viscosity classification.

In opening the discussion Dr. A. E. Becker, Standard Oil Development Co., showed that the need of such a classification was evident from the fact that a number of associations, as well as a number of users of lubricants, were attempting to classify lubricants according to viscosity. C. M. Larson, Sinclair Refining Co., endorsed the suggestion and analyzed the present need and the possibility of including at some later date a viscosity index and an extreme pressure symbol in any classification system adopted. The work of the two committees which were appointed will be limited for the present to viscosity classification numbers.

* * *

Improved Machines Effect Balance in Industry Under New Codes

SHORTER hours and higher wages . . . a common phrase in newspaper headlines and a topic of much discussion among individuals in all walks of life. Interpretations are many and varied but to the engineer this phrase has a significant meaning. The combination of shorter hours and higher wages will, he believes, necessitate a concerted effort to cut costs by improved methods and machines. The unit output of labor must be increased if industry is to meet the potential demands of its markets. Unless we are able to increase the capacity of the machine there will certainly be a retardation in our efforts to raise our standards of living.

The regulation of business under the laws of government will have its effect but almost everyone agrees that this movement toward a higher sense of social obligation, closer co-operation within industry, and effective curbing of unfair practices and cut throat competition will not be in vain. With prices and production controlled by various codes formulated by authorized trade associations it will be through lowered costs or in other words more efficient machines that the industrialist will be able to conduct his business successfully. New products and new markets also may be one of the answers to industry's future problems. Interesting history is in the making—the engineer must be prepared to do his part.

* * *

Unique Design Features Clock for the President's Swimming Pool

SEVERAL unique features characterize the new electric clock which recently was installed in President Roosevelt's swimming pool at the white house. Because the mechanism is sealed in the wall, the clock, developed by General Electric Co., Bridgeport, Conn., is equipped with two motors, one keeping the hands pointed to the correct time and the second being used only in case of power interruption to reset the hands. This second motor is controlled by a remote switch that causes the two motors, working in unison to turn the hands at ten times normal speed until correct time is reached.

* * *

Machine Defended by Noted Physicist in Address at Oberlin College

A SMASHING blow was dealt critics of the machine age, who would destroy mechanical devices to create employment, by Dr. Robert A. Millikan, head of California Institute of Technology and Nobel prize winner in physics. The occasion for his address on the machine age was the recent commencement exercises of Oberlin college. He was there for the one hundredth anniversary of the institution from which he was graduated in 1891.

Dr. Millikan declared that statistics prove the machine always has created more employment than it destroys. For the first time in history, mankind—at least in the western world—faces a century in which it may be assured that all its physical wants can be more than satisfied; that it therefore has the possibility of readily developing its intellectual, moral and esthetic nature.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

THOUGH identified with civil engineering, Prof. T. R. Lawson the new president of the American Society for Testing Materials, has a common interest with mechanical engineers in the testing of materials. In connection with various investigations in the testing laboratory of Rensselaer Polytechnic institute where he heads the civil engineering department, he devised much special equipment necessary for this work.

Graduating from Rensselaer in 1898, his affiliation with this engineering school since has continued. Prof. Lawson was successively instructor, assistant and associate professor, and since 1908 has been professor of rational and technical mechanics. Many firms have retained him as a consultant along structural and hydraulic lines.

Membership in the A. S. T. M. dates from 1907. He has taken an active part in committee work and for the past two years has been vice president of the society. Important research investigations on welding structural steel, various concrete investigations, including permeability, have been conducted under his guidance.

MEMBERS of the American Society of Mechanical Engineers are looking to Paul Doty as their next president, the post for which he recently was nominated. His affiliation with the society dates back to 1891 when he became a junior member. Active membership was granted him in 1904 and since then he has served as chairman of the committee on local sections, as manager and also as vice president. He now represents the A. S. M. E. on the American Engineering council.

Birthplace of Mr. Doty was Hoboken, N. J., May 30, 1869. Upon graduation from Stevens Institute of Technology with a degree in mechanical engineering, he entered the gas industry with which he has been identified most of his life. Responsible positions in high executive roles with numerous utility, financial and business organizations characterize his career. While residing in Michigan where he served as president of the Michigan Gas association, he was actively interested in establishing the first gas scholarship course at the University of Michigan.

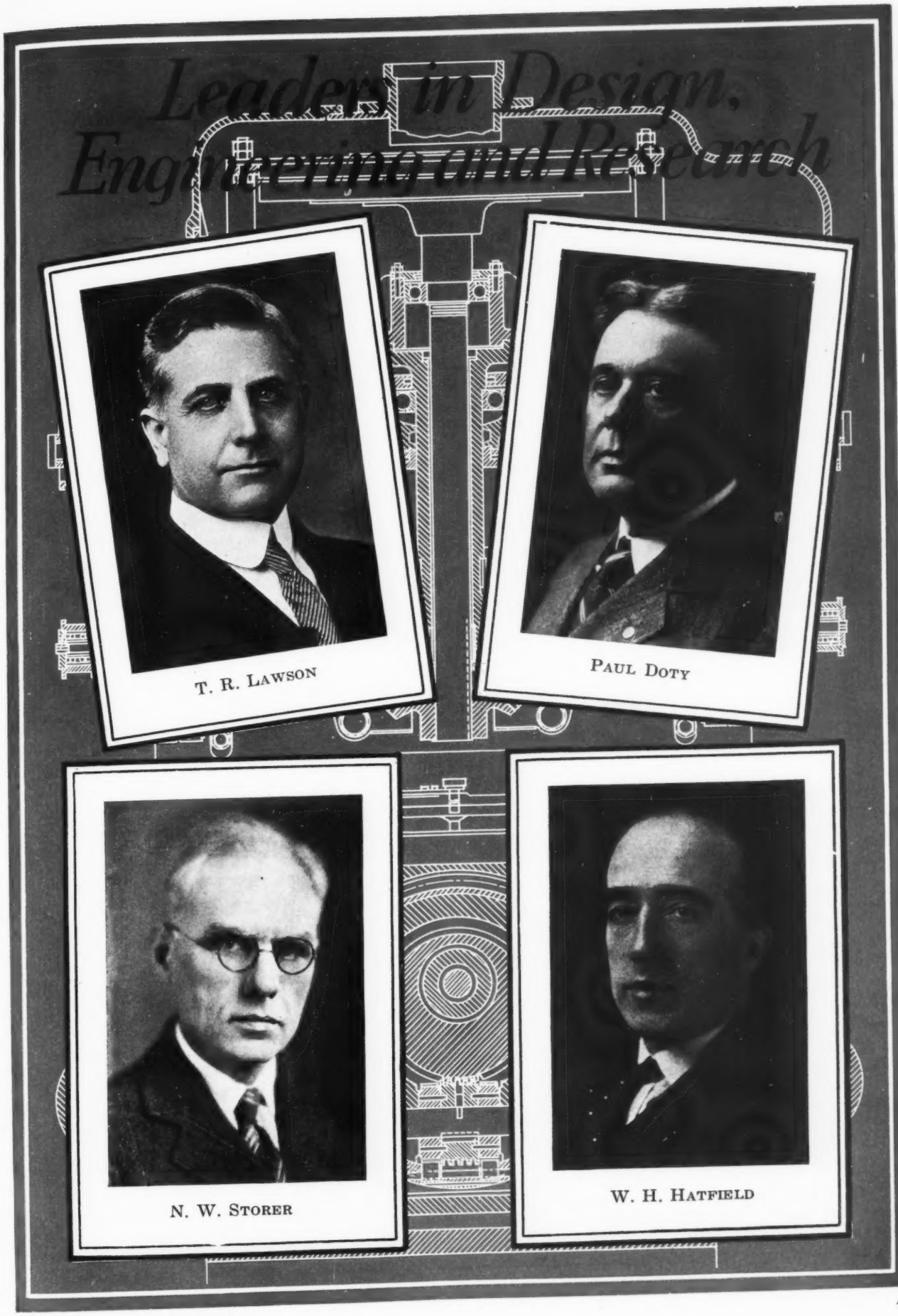
When the United States entered the World war he joined the Corps of Engineers, holding the rank of major until he was commissioned lieutenant colonel in 1919. At present Mr. Doty is chairman of the Minnesota State Board of Registration for Architects, Engineers and Land Surveyors.

FOR his notable accomplishments in design and development of electrical street railway equipment, Norman W. Storer has been awarded the Lamme medal. As a Westinghouse consulting engineer he will be remembered as the originator of the bi-way transportion system (M. D., July, 1932, p. 19), in which two trains, one running continuously, are operated on parallel tracks. The idea is a development of the principle of the moving sidewalk.

Orangeville, Trumbull county, Ohio, was his birthplace. After graduation from Ohio State university with the degree of mechanical engineer in electrical engineering in 1891, he joined Westinghouse. In May 1893 he started in design work, developing a line of small direct current multipolar generators and motors. Mr. Storer was appointed engineer of the railway division of the engineering department in charge of railway development work in 1904.

Many technical papers have been presented by Mr. Storer and his activity in the American Institute of Electrical Engineers includes such offices as manager, vice president, committee chairman, etc. He also is a member of the American Society of Mechanical Engineers and other technical groups.

AS DIRECTOR of the Brown-Firth Research Laboratories, Sheffield, England, and technical advisor to Thomas Firth & John Brown Ltd., Dr. W. H. Hatfield wields an important influence in the field of metals used in the design of machinery. For his extraordinary accomplishments in metallurgy, the Bessemer medal,


Leaders in Design,
Engineering and Research
T. R. LAWSON
PAUL DOTY
N. W. STORER
W. H. HATFIELD

one of the most coveted honor in Great Britain, has been awarded him.

Dr. Hatfield, Mappin medalist and associate of Sheffield University college in 1902, began his career in the laboratory of H. Bessemer & Co. Ltd. After two years he became associated with Meadow Hall Works of J. Crowley & Co., subsequently joining the board of that company as technical director. In 1915 he assumed control of the Brown-Firth Research Laboratories.

Eminent research work in the rustless steel field has been carried out by Dr. Hatfield. His work on properties of steel at high temperatures is well known. The engineering profession holds his book on "Cast Iron in the Light of Recent Research" as a recognized work on the subject. In 1928 Dr. Hatfield gave the Campbell memorial lecture before the American Society for Steel Treating. Additional honors include: First president of the Sheffield association of Metallurgists and Metallurgical Chemists and the degree of doctor of metallurgy from the University of Sheffield.

* * *

H. L. Doolittle, designing engineer, Southern California Edison Co.; William L. Batt, president, SKF Industries Inc.; Ely C. Hutchinson, president, Edge Moor Iron Co.; Elliot H. Whitlock, consulting engineer, Cleveland, have been nominated vice presidents of the American Society of Mechanical Engineers.

* * *

John P. Ferris, formerly chief engineer, Oilgear Co., Milwaukee, has accepted an appointment from the Tennessee Valley commission to make a study of prospects for proposed decentralization of industry in that region. A picture and biographical sketch of Mr. Ferris appeared in the July, 1932, issue.

* * *

C. T. Doman, who resigned recently as chief engineer and research engineer of the Franklin Automobile Co., and E. S. Marks have designed a new air-cooled engine at Syracuse, N. Y., for trucks, compressors and general industrial use.

* * *

Samuel Epstein, metallurgist, Battelle Memorial institute, Columbus, O., has been awarded the Dudley medal of the American Society for Testing Materials.

* * *

N. K. B. Patch, Lumen Bearing Co., Buffalo, is president of the new Nonferrous Foundry association which was organized recently in Chicago to aid in industrial recovery. Allen B. Norton, Aluminum Co. of America, Cleveland, is vice president, and Sam Tour, Lucius Pitkin Inc., New York, secretary and treasurer. Committees have been appointed to consider a plan for accumulating the necessary statistics of the industry and to formulate a suggested code under the National Industrial Recovery act.

* * *

Thomas S. Hammond, president of the Whiting Corp., Harvey, Ill., and also president of the Illinois Manufacturers' association, has been appointed by Gen. Hugh S. Johnson as executive director of the National Emergency Re-employment program. His picture and biographical sketch appeared in the June, 1932, issue.

* * *

Charles Page Perin, Perin Engineering Co., New York, received the honorary degree of doctor of engineering at Renssalaer Polytechnic institute recently.

* * *

John Nielsen, mechanical engineer, and Fred Bruening, formerly in the experimental division of the Barber-Colman Co., Rockford, Ill., are principals in the Nielsen-Bruening Engineering Co., Beloit, Wis., which recently acquired the Beloit Mfg. Co., pump manufacturers.

* * *

Henry Shearer, vice president and general manager of the Michigan Central railroad, Detroit, recently made an official inspection trip on the new Clark autotram described on page 16, Jan., 1933, MACHINE DESIGN. Destination of this revolutionary railcar was Chicago where it went on exhibition at the World's Fair.

* * *

Frank E. Case, assistant to the engineer of the General Electric transportation department, recently retired after 42 years of service. When he was transferred to Erie, Pa., in 1926 he was placed in charge of the motor and locomotive design divisions, remaining in this capacity until the design sections were consolidated with the general engineering division. Mr. Case has taken out more than 100 patents.

* * *

Dr. A. E. Becker, Standard Oil Development Co., is chairman of the new refinery viscosity classification subcommittee of the A. S. M. E. lubrication engineering committee. A second subcommittee on viscosity needs of users is headed by William F. Parish. A brief resume of the meeting at which was discussed a system of viscosity classifications for industrial lubricants will be found on page 45.

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

WHEN the centrifuse brake drum was originated sometime ago engineers over the country viewed the development with interest, not only because the idea involved an alloyed iron-lined drum but because the machine which produced it embodied several ingenious mechanisms. The manufacturing method that made use of multiple units on a turntable was described on page 32 or the May, 1932, issue; however, the centrifugal casting machines, although mentioned, were not described in detail. In view of the fact that Donald J. Campbell, of Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., recently was granted a patent on the centrifugal casting unit, the details of the device are presented briefly to supplement the earlier discussion.

In effect the process concerns the deposition of molten metal at the inner side of a revolving pressed metal drum so that the two materials will be fused together. The machine in which this is accomplished is shown in Fig. 1; the manner in which the composite or finished drum

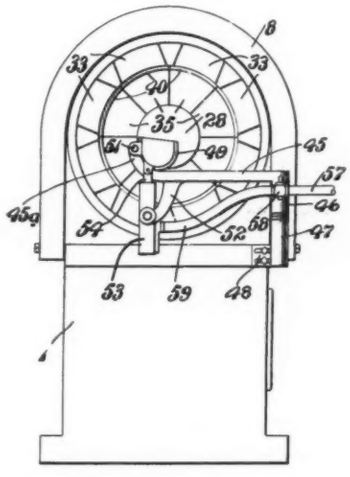


Fig. 1—End elevation of centrifugal casting machine showing the pouring arrangement in which tilting of the ladle is controlled by a vertical air cylinder. The ladle is semicylindrical and facilitates uniform pouring in measured amounts

is released from unit, is depicted in Fig. 2.

Ladle mechanism, Fig. 1, for depositing the cast metal against the inner side of the pressed metal drum, is designed to permit a measured amount of molten metal to be poured to meet the required thickness of the product. Arm 45 has a branch 52 extending downwardly, on which a vertical air cylinder 53 is pivotally mounted. A piston rod 54, operated by the action of compressed air entering the lower end of cylinder 53, extends from the upper end of the cylinder and is connected to lugs on the ladle, this ladle being in the form of an elon-

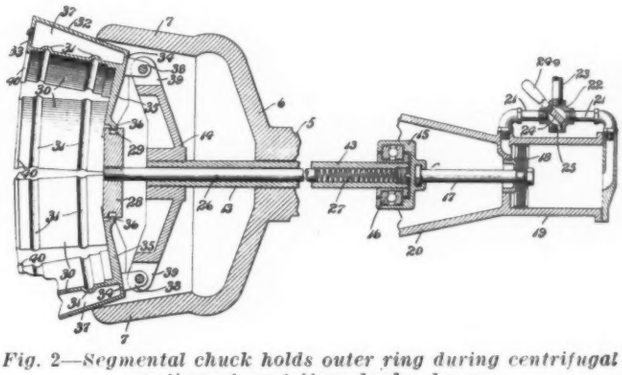


Fig. 2—Segmental chuck holds outer ring during centrifugal casting of centrifuse brake drums

gated cylinder to permit pouring to take place directly above the rotary drum. On upward movement of rod 54 the ladle is tipped from its horizontal position. A valve in housing 58 is utilized for controlling the flow of air so as to tip the ladle to insure uniform pouring.

In Fig. 2 the head of the centrifugal casting machine is shown in its outer position. A contractable drum holder fixture, a unique feature of the unit, is connected with the heads 14 and 28. This fixture is made up of a number of segments, each having an inner arc-shaped side 30 with spaced grooves 31 therein.

From the segments, fingers 38 extend rearwardly and are connected to lugs 39. On actuating the piston 18 the first movement moves the tubular shaft 13 and head 14 inwardly, and through connecting fingers 38, the various segments are drawn together. It is apparent that this composite member, when closed becomes an effective chuck for a brake drum.

The number of the patent is 1,917,872.

ELECTRICAL switches employing mercury need no introduction to design engineers but there has been developed one which employs centrifugal force instead of gravity alone, that

may be new to many. George A. Gillen is the inventor and the patentee; Oakes Products Corp., North Chicago, Ill., the assignee.

The switch structure, Fig. 3, comprises a cylindrical cup 10 of material such as bakelite. A transverse wall or plate 14 is mounted within the cup and divides it into an inner chamber 15 and an outer chamber 16, the former being concave and the latter cylindrical and of larger diameter and volume than 15. Partition 14 has a circumferential row of restricted ports 17 to allow passage of the mercury from one chamber to the other during operation of the switch.

Extending through the bottom wall of cup 10 is a contact block 18, the inner end of which is

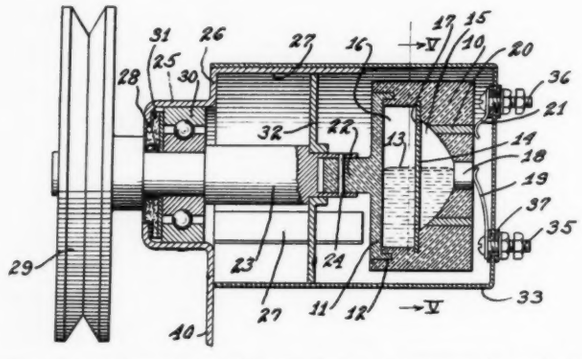


Fig. 3—Action of centrifugal force on mercury in switch cup breaks electrical circuit

exposed to the mercury and outer end to contact 19. Surrounding the inner contact block is a contact ring 20 extending through the cup bottom for exposure to the mercury. Contact 21 is its electrical outlet. The quantity of mercury in the cup is such that when the cup is at rest the level of the mercury will connect electrically the contacts 18 and 20. During slow rotation of the cup as for example during starting of an engine by its starting motor, the mercury will sustain its level and keep the contacts connected. However, when the speed is increased suddenly and rapidly the action of centrifugal force will cause displacement of the mercury, crowding it outwardly along the inclined bottom and through ports 17 into the outer chamber 16. As the mercury is receded, inner contact 18 no longer will have electrical connection with contact ring 20. When the speed decreases, however, contact again will be established.

The patent is designated No. 1,917,581.

A COMBINATION of mechanical elements have been employed by John P. Kelly to provide a mechanism for overcoming dead centers. In general the invention relates to a mechanical movement for converting reciprocatory into rotary motion. Drawing, Fig. 4, is an elevation partially in section showing the device as employed to drive a train control governor mounted on extension of shaft 61, but not shown.

Normal tension of springs 18 and 20 is greater than the inertia of the crankshaft. Therefore, with the left-hand end of shaft 8 connected to a locomotive piston crosshead, this shaft and cylinder element 9 will be reciprocated as a unit and through connecting rods 11 and 12 will rotate gears 6 and 7 and the governor. The crank to which connecting rod 13 is pivoted is offset 30 degrees with respect to the cranks of connecting rods 11 and 12. As nut 82 on shaft 8 continues to oscillate it never quite reaches either element 17 or 17′ of shaft 83 because these elements are at the same time being oscillated by crank of connecting rod 13. Therefore in operation connecting rod 13 and its crank simply drive carrier shaft 83 back and forth without affecting the drive.

Assume that shaft 8 has ceased to operate or is moving so slowly that there is not sufficient momentum in the crank and governor to carry the crank past dead center position. Under such circumstances, with the crank at dead center and with movement of cylinder 9 consequently blocked, a further movement of shaft 8 by compression of one of the springs 18 or 20 still may occur.

The shaft, in moving to the right, carries with it the spring retaining horseshoe 32 and spring stop 23. Obviously, therefore, the distance between these two elements remains the same and the semi-compressed state of spring 18 remains unaltered. Since the spring retaining washer 19 is adjacent to part 10′ of the connecting rod carrier 10, now in dead center position, movement of this spring retaining washer cannot occur. Consequently as the shaft 8 moves to the right, the spring 20 is compressed until the

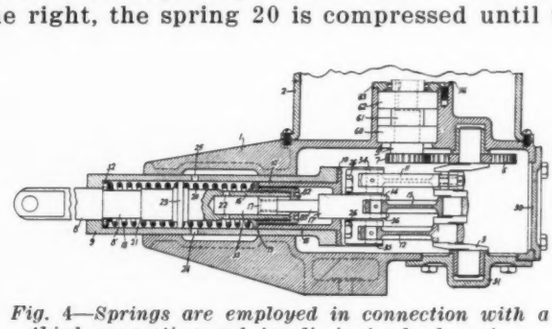
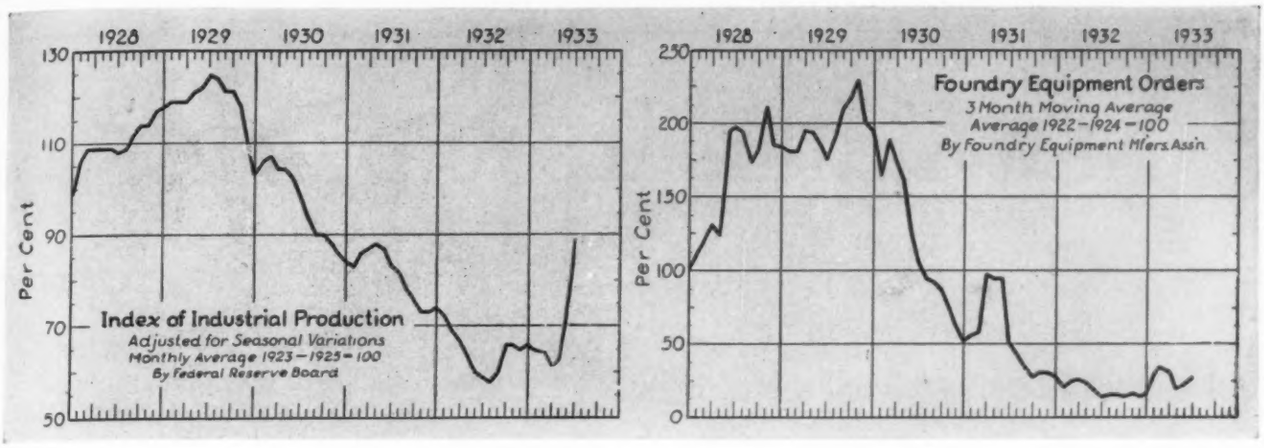


Fig. 4—Springs are employed in connection with a third connecting rod to eliminate dead centers

nut 82 on the right-hand end of shaft 8 encounters element 17′ of the auxiliary connecting rod drive shaft.

As shaft 8 continues to move to the right, it carries the auxiliary connecting rod drive shaft with it and through the medium of connecting rod 13, moves crank 3 off dead center.

Associated Electric Laboratories Inc., Chicago, is assignee of the patent which is designated No. 1,906,614.

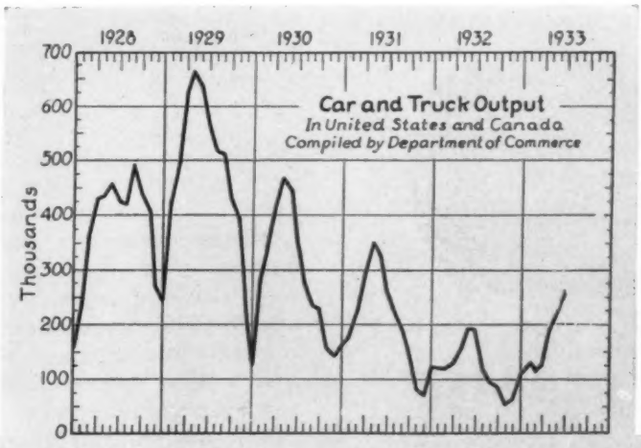


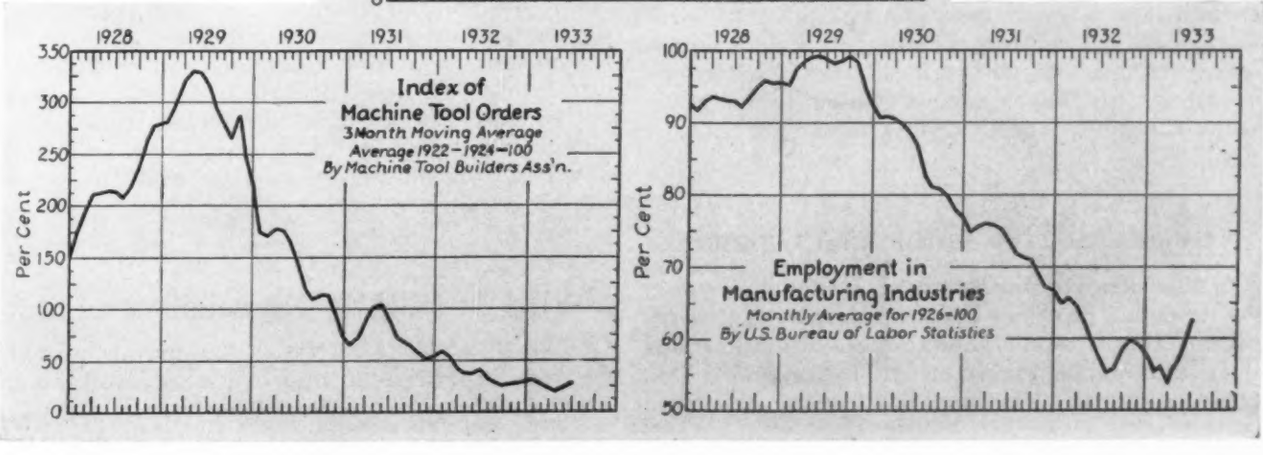
How Is Business?

IT IS an established fact that increased buying power of the ordinary individual is the only factor that will assure maintenance of the present level of industrial production and the improvement of that level. The lack of this buying power has been the fundamental cause of the troubles experienced by industry.

Restoration of wages and the assurance of an adequate wage has been the paramount interest of the administration in its efforts to stabilize the country. The codes drawn up thus far are of primary benefit to the shop man and laborer, yet some companies have gone even farther by assisting the enormous group of "white collar" workers, while this entire group will receive secondary benefit from the business improvement.

Concrete examples of the value of increased buying power can be seen at every hand. Demand, coming on top of a deplorable lack of supply, already has pushed up commodity prices. Retail sales volumes are increasing at a terrific rate. Youngstown, home of thousands of steel workers, all benefited by the increase in operations, reports automobile sales more than double those secured a short year ago. The returning worker is spending his money. Thus benefit is received by the sales companies and the manufacturers. The worker gets more work — more money.





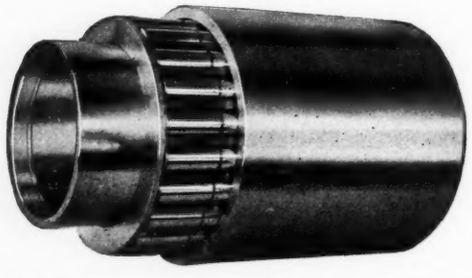
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Alloy Steel Employed in New Bearings

INDUSTRIAL roller bearings, a modification of the railway type but built on the same fundamental principles of design, now are being manufactured by Fafnir Bearing Co., New Britain, Conn. The bearing consists of the conventional inner and outer rings and roller cage assembly, employing an alloy steel which has a high fatigue value. Rolls are of high carbon chrome steel and are hardened throughout. The cage itself is fabricated from specially form-rolled spacer bar stock with carburized and hardened end rings. Additional capacity is gained by increasing the roll length and by using two rows of rollers where necessary.

Solid rolls only are used as the rollers are held in place and guided by spacer bars rather than by rivets through the rolls themselves.



Solid rollers are employed in recently introduced antifriction bearing

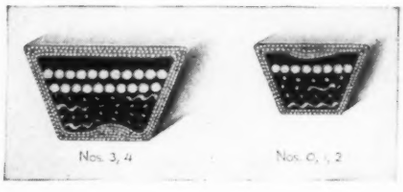
Spacer bars are riveted to the end rings, while each roll is made in two parts to assist in preventing any possibility of skewing. The entire assembly is made with a fixed radial clearance to allow for the expansion which takes place when the inner ring is shrunk to the shaft.

New Metal Has Unusual Properties

DEEP drawing sheet metal which has many unusual physical properties new to ferrous metals and of importance in metal stamping has been announced by American Rolling Mill Co., Middletown, O. The material has the ability to be drawn and spun, permitting manufacturers of pressed metal products to adopt still more intricate designs. It retains its ductility and tensile strength permanently. Tempering does not destroy its drawing qualities. In the manufacture of parts where it is essential that the surface be unimpaired, the new metal is said to be of especial value.

V-Belts Are Improved

A NEW and improved type of Goodyear Emerald Cord V-belt now is being marketed by Worthington Pump & Machinery Corp., Harrison, N. J. A basic feature of the new



V-belt redesign provides greater concentration of load about the neutral axis

belts, shown herewith, is a greater concentration about the neutral axis of the belt of the load carrying capacity. Sizes 0, 1 and 2 have one endless cord in one plane, while sizes 3 and 4 have two endless cords in two planes. All cords are completely embedded in rubber, thus affording full insulation for the control of internal heat. The tension and compression sections of the belt are composed of rubber, with layers of fabric distributed through the compression section to prevent excessive flexibility.

The belt is molded to shape, and is enclosed in a fabric envelope. Fabric for the envelope is cut so that the threads run on the bias. The envelope is "flipped" on the belt (not spiraled) and is so placed that the edges overlap on the top or bottom.

Wire Coating Is Especially Ductile

ZINC-COATED wire which has unique properties is a recent innovation of Bethlehem Steel Co., Bethlehem, Pa. The Bethanized wire

Folks-

--this is a pin from one link of a Baldwin-Duckworth Chain. It would require pages to explain the engineering experience which must enter into its design, the expert attention required in the selection, inspection and heat treating of materials used, and the manufacturing precision which is a part of its construction.

For example, this pin measuring 5/16 in diameter must have sufficient strength to carry a load of 33 h. p. To accomplish this, every shipment of steel is inspected and tested separately before a single operation is started. Throughout the manufacturing process several other inspecting and testing operations are performed, and individually checked against established standards.

This engineering knowledge and efficiency and this manufacturing accuracy are some examples of the many details responsible for our deserved reputation of producing

DEPENDABLE DRIVES FOR EVERY PURPOSE

BALDWIN-DUCKWORTH CHAIN CORP.

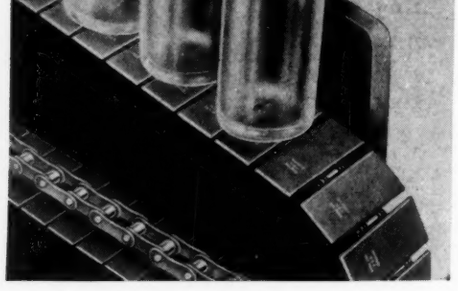
SPRINGFIELD, MASSACHUSETTS

FACTORIES AT SPRINGFIELD AND WORCESTER, MASSACHUSETTS

is said to have a coating which is more ductile, tighter, tougher, more uniform and purer than the similar product manufactured previously by the company. High resistance to corrosion is offered. The product is available in standard gages from 16 to 6.

All Steel Conveyor Chain Announced

UTILIZING the recognized features of the standard finished roller chain and adapting them to slow speed conveyor work, Whitney Mfg. Co., Hartford, Conn., has developed a conveyor chain for use on bottling, packaging and similar machinery which requires a built-in



Pitch diameter of conveyor chain is double that of standard chain

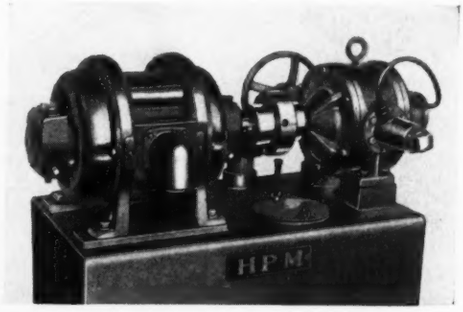
part of this type. The pitch dimension of the new chain, shown herewith, is double the standard roller chain pitch which allows them to run on standard cut sprockets, the rollers meeting every other tooth. Outside dimensions of the smaller sprockets are adjusted to compensate for the change in chordal distance to the extended pitch.

The chain can be furnished in various combinations of stainless steel parts or in all stainless steel construction, according to the needs of individual equipment. A wide range of selection is offered which also includes the possibility of improved appearance by employment of the all-steel chain.

Announces Hydraulic Power Unit

TO FACILITATE the application of the new radial oil pressure pumps built by Hydraulic Press Mfg. Co., Mount Gilead, O., to various types of hydraulically actuated machines, a line of standardized hydro-power units has been developed by the company. Each unit, shown herewith, incorporates a radial pump pressure generator, direct driven from an electrical motor through a flexible coupling. Both pump and motor are mounted on a base which is made of steel plate, formed and welded. This is enclosed completely so as to serve as a reservoir for the oil used as pressure fluid and lubricant.

This reservoir is equipped with removable end cover, covered filling strainer, air vent filter, level gage and drain valve. It also is fitted to



Hydro-power units facilitate application of pumps to machines

take a copper coil for cooling water circulation when operating conditions require auxiliary oil temperature regulation.

Pressure output of the pump is regulated by an automatic control which may be adjusted for any value within the operating limits up to 3000 pounds per square inch. A modified form of this control is provided with a second adjustment whereby the volume of pump discharge may be regulated to any amount from zero to maximum.

Universal Motors Are of Small Size

TWO new motors for machines requiring 1/40 or less horsepower have been introduced by Electric Motor Corp., Racine, Wis., manufacturer of fractional horsepower universal motors. The model "AG," shown herewith, is electric-

Universal motor speed can be varied over a wide range giving full torque at all speeds

governor controlled, and can be varied in speed with a range down to 3000 revolutions per minute, giving full torque at that speed. Its dimensions are 4½ inches overall including pulley and governor housing, and 3¼ inches high including the base.

The type "B" universal motor, shown in the

IN THE GLOAMIN'

● "Gee, it's lovely roamin' in the gloamin'," sings Sir Harry Lauder.

The gloaming for machine designers will come when every purchaser of their equipment employs operators who keep it running at peak efficiency without grief or breakdowns.

But until that time comes, here is a practical suggestion: Design Alemite Lubrication Systems into your equipment and then specify the correct Alemite Industrial Lubricants which shall be used in these systems (and no others!)

That is a safeguard against mishandling of equipment which every designer will appreciate —after one trial. Those who have tried it say that it is the best self-protection.

Alemite's Lubrication Engineers have made long studies of every industrial lubrication need. With them it's not a case of turning out a "batch of grease" that may or may not lubricate under a given set of conditions. Every Alemite Industrial Lubricant has a definite use as a LUBRICANT—the closest to lubrication perfection science has yet developed.

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ALEMITE CORPORATION (Division of Stewart-Warner)
1890 N. Crawford Avenue, Chicago, Illinois 778

Gentlemen: I am interested in information regarding Alemite Systems and Lubricants from the designer's standpoint.

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Company.....

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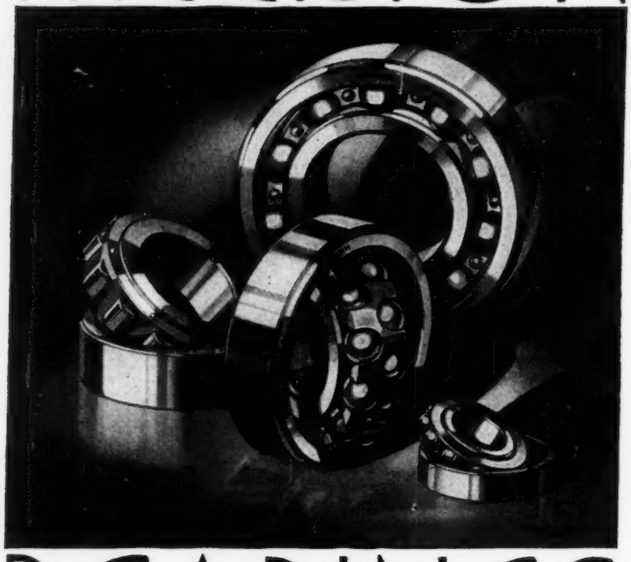
PIONEERS IN SPECIALIZED LUBRICATION FOR INDUSTRY

PRECISION



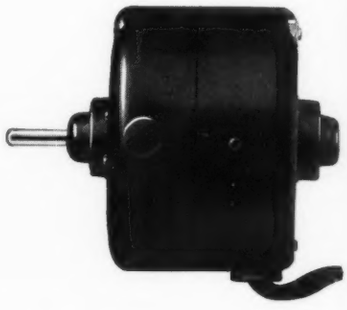
BEARINGS

PRECISION—as the term defining the characteristics distinctive of NORMA-HOFFMANN Bearings—comprehends ALL those qualities which reveal themselves in higher anti-friction efficiency, greater speed-ability, better performance, longer life, fewer replacements, improved production. ✲ ✲ ✲ These are the definite and tangible gains which accrue to the builder and user of any machine in which NORMA-HOFFMANN PRECISION Bearings are incorporated. ✲ ✲ ✲ Write for the PRECISION Bearing Catalogs. ✲ ✲ ✲ Let our engineers work with you—without obligation.

"NORMA-HOFFMANN"
PRECISION BEARINGS
BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORP., STAMFORD, CONN., U. S. A.

accompanying illustration, can be mounted horizontally or vertically, on a base or by means of screws at the shaft extension end. The screws may be extended through the case to give an additional mounting position. This unit has an



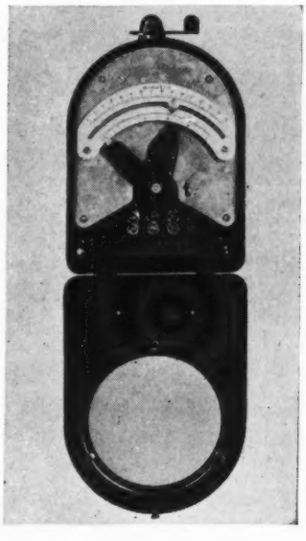
Variety of mounting positions are available with application of small universal motor

overall length of the body of motor case of 2 inches, length from bearing to bearing of 2 7/8 inches and diameter of 2 3/4 inches. Power output can be varied to suit individual needs.

Both motors have self-aligning composition, semi-oilless bearings, and an oil reservoir consisting of a felt washer housed in the bearing boss at the ends of the case.

Electric Timers Have Many Uses

ELECTRIC timers that lend themselves to many automatic and remote control applications have been announced by General Electric Co., Schenectady, N. Y. By combinations of two or more timers, or by using one in con-

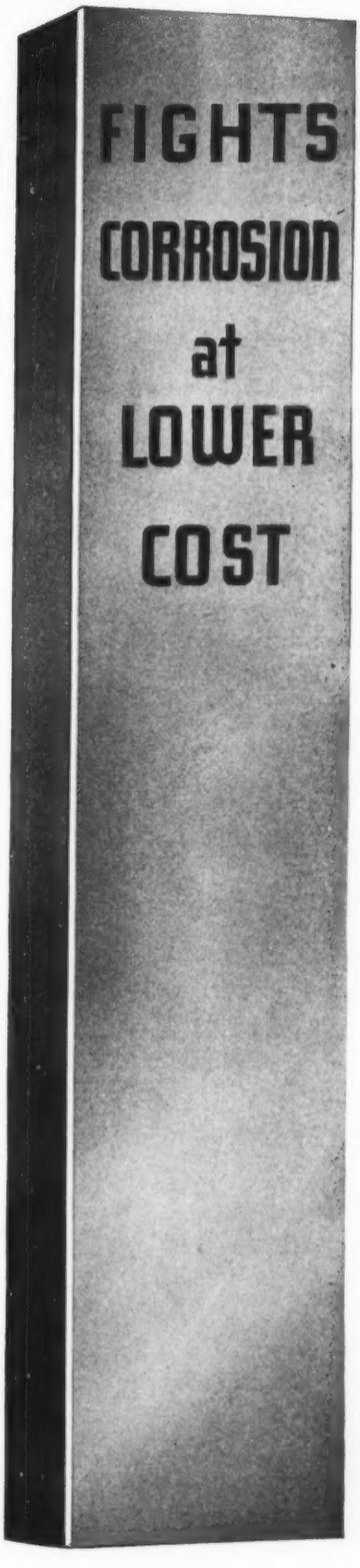


Resetting of electric timers is automatic whenever the circuit is de-energized

junction with other types of automatic time switches, it is possible to meet a wide range of process schedules. The timer, designated as type TSA-10, is shown herewith.

Timing is started by closing a switch. Resetting is automatic when the control circuit is

USS PLYKROME



● Here at last is an effective steel for combating corrosion at low cost. For Plykrome costs only half as much as solid Stainless Steel, yet it is just as effective in any application in which corrosion resistance is required only on one side.

Plykrome is thoroughly tested. Its patented method of production precludes the possibility of any separation of the Stainless Steel veneer from the base plate.

Plykrome may be fabricated by any of the usual methods without special equipment.

For further information and advice on the application of Plykrome to specific installations, write to the Illinois Steel Company.

USS STEEL

Illinois Steel Company

208 S. LA SALLE ST., CHICAGO, ILL.

SUBSIDIARY OF
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U S S CHROMIUM-NICKEL ALLOY STEELS ARE PRODUCED UNDER LICENSES OF THE CHEMICAL FOUNDATION, INC., NEW YORK, AND FRIED. KRUPP A. G. OF GERMANY

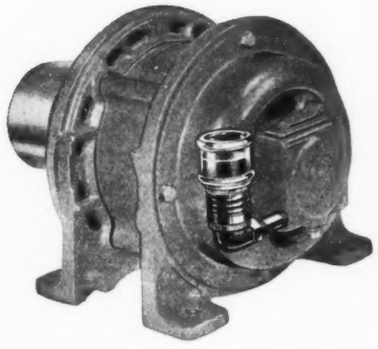
de-energized. The time period is adjustable over a wide range. When used as a process timer, the unit can be arranged to operate a signal or terminate a process at the end of a predetermined period. By the use of relays and timers together, entirely automatic control can be provided for almost any process.

Bar Iron Resists Vibration

A SPECIAL grade of bar iron which is recommended by its maker for service where severe vibration is encountered is being manufactured by Reading Iron Co., 401 North Broad street, Philadelphia. By virtue of its unique structure, a bar of Nordic iron reacts to vibrational stresses like a closely knit bundle of individual wires, rather than a solid bar. The material has exceptional resistance to impact or shock resulting from a sudden blow or suddenly applied load.

Oilers Operate Automatically

AUTOMATIC oilers in two types, "Constant Level" and "Thermal," now are being marketed by Speedway Mfg. Co., 1834 South Fifty-second avenue, Cicero, Ill. The constant level oilers, shown herewith, are designed especially for use on electric motor bearings and other reservoir bearings with oil ring packing, or ball or roller bearings where oil in the reservoir should be maintained at a predetermined level. This is accomplished by means of a tube which permits air to enter and oil to flow from the reservoir when the level of oil in the bearing reservoir drops below the fixed and proper level. Flow is stopped automatically when this level is attained. The thermal oilers, designed for use on sleeve bearings of the open type, are operated wholly by change in the bearing temperature. Heat in the bearing causes an ex-



Oil level is maintained automatically by tube which permits air to enter and oil to flow when the level drops below a fixed point

What every designing engineer should know about FLEXIBLE SHAFTS

1. That for all transmission or control applications involving up to 1 H.P., where conditions are such that a solid shaft cannot be used, the *flexible shaft*—a single self-contained unit—is the simplest and most readily applied alternative.

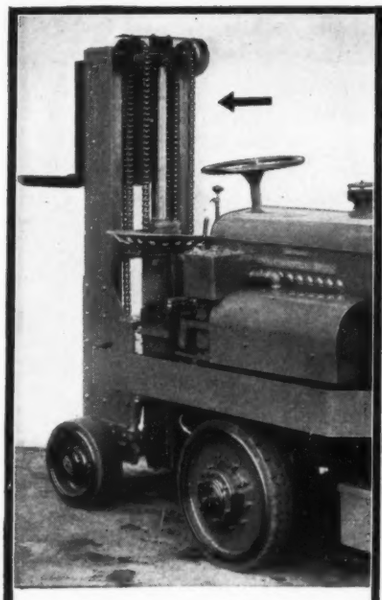
2. That a properly designed and honestly made flexible shaft is fully as reliable and enduring as gears, chains and sprockets, universal joints or any of the other comparatively complicated mechanical elements serving the same purposes—a fact that has been established beyond question by the performance of millions of feet of S. S. WHITE Shafts on a great number and variety of industrial applications.

3. That S. S. WHITE Shafts are real *SHAFTS*, built up practically solid of layers of highest grade steel wire—the nearest approach possible to a flexible solid shaft . . . that they are made flexible without sacrifice of strength by a special process of winding on special machines perfected through years of shaft manufacturing experience.

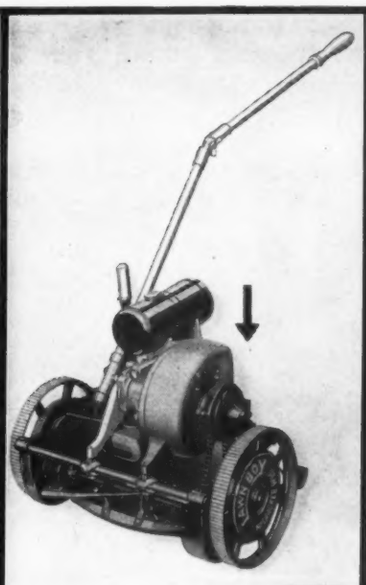
4. That S. S. WHITE Shafts are available in a range of "flexibility" characteristics and sizes sufficiently wide to meet every need for a flexible element of transmission or control within their power range—with the necessary shaft ends, casings and couplings to conform.

5. That the place to go for a prompt and thoroughly responsible answer to any question relative to flexible shafts, or for assistance in working out a specific application is

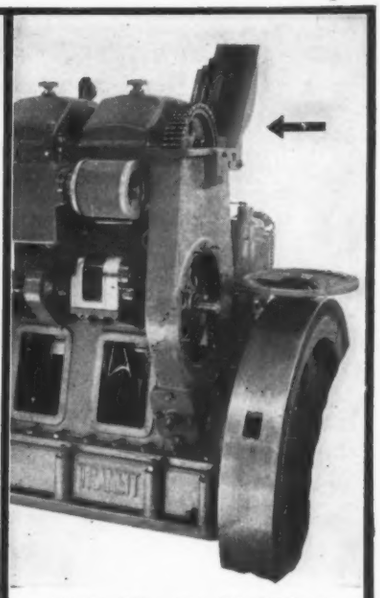
The S. S. WHITE Dental Mfg. Co.
INDUSTRIAL DIVISION
154 West 42nd St., New York, N. Y.



Industrial High Lift Truck—Diamond Roller Chain for lifting, because it has no "weakest link."

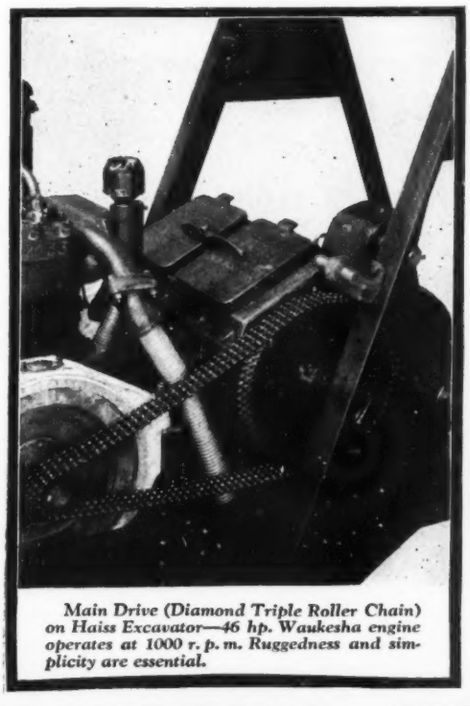


Power Lawn Mower made by Outboard Motors Corp. Diamond Roller Chain for driving mower from ½ hp. 1800 r.p.m. motor. Durability, compactness and economy are required.



National Transit multi-cylinder gas engine, convertible to solid injection Diesel engine. Diamond High Speed triple chain was selected for driving the cam shaft, water pump and fuel pump, because it is accurate, dependable and quiet.

Improve Your Product with Diamond Chain



Main Drive (Diamond Triple Roller Chain) on Haiss Excavator—46 hp. Waukesha engine operates at 1000 r. p. m. Ruggedness and simplicity are essential.

DIAMOND ROLLER CHAIN gives the user of your product the ultimate in service and efficiency. Hundreds of manufacturers have used Diamond Chain consistently for over a score of years.

If your machines are power-driven, if motion is to be imparted from one member to another — investigate Diamond Chain advantages — long-life, maintained high efficiency (98-99%), simplicity and applicability. Let us mail our Booklet No. 104-A, *"Simplifying and Improving Machine Design."*

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue Indianapolis, Ind.
Offices and Distributors in All Principal Cities

This Diamond on every link identifies the Diamond Drive

DIAMOND ◇ DRIVES for Every Industrial Need

Quiet — Clean — More Compact per H. P. Transmitted

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue, Indianapolis, Ind.
Gentlemen: Please send me a copy of Booklet 104-A, *"Simplifying and Improving Machine Design."*

*Name*_____

*Firm*_____

*Address*_____

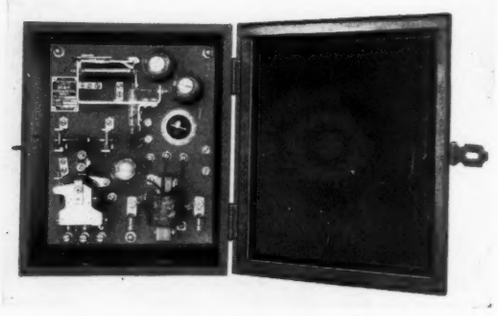
*City*_____ *State*_____

(A-7518)

pansion of the air in the thermal chamber, forcing small quantities of oil to the bearing. Both types of oiler have a visible lubricant supply.

Switch Controls Time of Welding

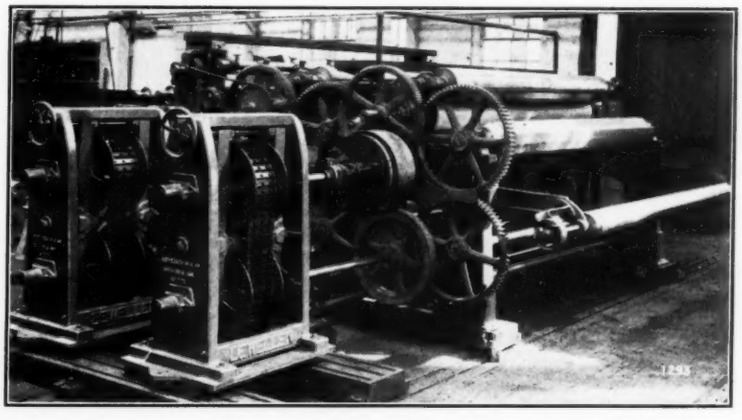
FOR use in connection with resistance welding machines, Electric Controller & Mfg. Co., 2690 East Seventy-ninth street, Cleveland, has announced an automatic weld timer, shown herewith. This timer does not provide a definite amount of time for each weld, but varies the time automatically in inverse proportion to the rate of current flow to produce an efficient weld with each operation. The unit consists of a rectifier tube which charges a fixed condenser in proportion to the rate of current flowing in the welding circuit. When the charge reaches an amount sufficient to pass current through two neon gas filled tubes, a small relay is operated which in turn opens the relay controlling the main line contactor. The tubes are in the circuit only when the welding current is on so that as soon as the main welding circuit is opened, the weld timer is ready for the next operation.



A definite amount of time for each weld is provided by new automatic timer

GRAVITY rollers which have their ends formed in one piece to receive the bearing are offered for inclusion in machines by Standard Conveyor Co., St. Paul, Minn. A recess is formed in the end of the roller to receive a stationary dust shield fastened on the inner ball race. An inner steel shield also is made a part of the bearing, fitting closely against the inner race to retain the grease. The inner race is prevented from turning by a hexagon axle, while a correspondingly shaped hole is punched in the side rails, making a positive lock at this point.

LEWELLEN Transmissions in Paper Cutter Drive.



When Black-Clawson Company designed this large special cutter for a western board mill, they incorporated two No. 14 Lewellen vertical transmissions to control the knives. The two Lewellens are an integral part of the cutter. The constant speed shafts are coupled directly to the carrier rolls, while the variable speed shafts are coupled to the knife rolls. This simplifies design, eliminates chain or belt drives, and gives a wide range in length of cut and insures uniformity in length of board.

The LEWELLEN Transmission will solve your variable speed control problem to your satisfaction. Accuracy and infinitely variable speed are two characteristics of the Lewellen. It is built in horizontal and vertical types, in either the standard open design as shown, or where protection from acids, abrasives, water, steam or oil is desired, the Series 100 fully enclosed design will meet every requirement. Let us tell you why the Lewellen will save you money in the long run.

THE *Lewellen* MANUFACTURING CO.
COLUMBUS, INDIANA

"It costs no more to have the best"

Advertising and the Machine Age

•

Prepared by the
Bureau of Research and Education
ADVERTISING FEDERATION OF AMERICA

A FRIGHTFUL alarm went through the country a few months ago. It was one of the strangest alarms in all the history of mankind. People suddenly feared their own efficiency, their ability to produce goods for their comfort and satisfaction.

In normal times such an alarm would create hardly a ripple on the surface of our national thinking. But because we are now in a state of mental strain, any warning may frighten us, no matter how absurd. So millions shuddered at the sudden thought of our civilization being devoured by machines of our own creation.

For several thousand years man has been laboring to harness the forces of nature and bend them to the task of producing the material things which make civilization possible. Amazing progress has been made, especially in our own country. Even in these times of comparative distress, nearly all of us enjoy more of the satisfactions of life than were formerly available to the most fortunate few.

Much of this progress has been due to forces other than production efficiency. Invention and engineering science could not have done the job alone. Ability to make things is useless unless we also know how to distribute them. Every advance in the creative process necessitates an advance in distribution methods. Otherwise, progress is but a theory.

Under the only satisfactory social system which we know, goods must be distributed by selling them to the people who are to use them. All purchases must be voluntary and the money for this buying comes from industry itself.

The only possible threat from greater production efficiency arises from the lagging of our distributive machinery. At a time like the present every force, every influence for speeding up the selling process is a life-line back to prosperity. Even after normal conditions will have been restored, we still will be faced with the necessity of making the products of industry move faster into the hands of consumers. We have never really produced too much and we probably never will. At times, we may have too much wheat or too many hairpins but there are always many things of which we could use more than has ever been produced. In this sense we have never really had overproduction. At the peak of prosperity we produced only seven hundred dollars worth of goods and services per capita. We could happily use several times that amount.

One thing which America needs to do for the future is to devote an increasing amount of ingenuity and energy to the problem of distributing the goods which industry produces. Distributing means selling to consumers. In all the history of selling, there never has been a greater invention than that of advertising, which has become industry's most powerful sales force. Just as machines brought mass production, so advertising made mass selling possible.

America will continue to progress. Our inventors and engineers must be kept at their task of making life easier and more pleasant. But we must strengthen those forces which distribute the fruits of their creation. One of the most important of these is intelligent advertising. It is not only business which benefits from advertising. In this stage of civilization, the welfare of every man, woman, and child is dependent on the efficient distribution of our manifold products. Good advertising is one of the most essential forces in that process.

This is one of a series of fifteen articles prepared by the Bureau of Research and Education of the Advertising Federation of America, as a part of its program to promote a better understanding of advertising, renew the confidence of business men in its use, and increase its effectiveness as a marketing force.

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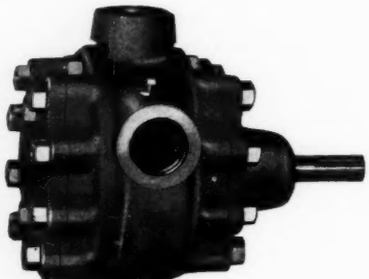
ADVERTISING FEDERATION OF AMERICA
330 W. 42nd St., New York, N. Y.

ROPER

TRADE MARK

(Builders of Pumps Since 1857)

Pumps For All Purposes



Hydraulic:

A complete line of Hydraulic Pressure Pumps for actuating machine tools, road machinery, elevators, lifts, stokers, etc. Wide variety of sizes, capacities, and mounting designs. Types for either lubricating or non-lubricating liquids. Pressures up to 1,000 lbs.

General Industrial:

Large and small capacity pumps for thick liquids or thin—acids or alkalies—corrosive or combustible. Pumps for machine tools; for soap, glue, rubber, dye and chemical works; for textile plants; for molasses, liquid foods, asphaltum, grease, brine, gasoline, lacquer, beer. Skilled engineering and production forces to produce what you want.

Coolant:

One way and reversible types with wide range of capacities and flexibility of mounting design,—for all types of machine tools. With or without built-in relief valves. Only two moving parts. Positive delivery; smooth, forceful, non-pulsating flow.

Hand Transfer:

Portable or permanent attachment to any type of container. For light or heavy liquids. Also non-ferrous, non-sparking, non-corrosive hand pumps which are fire proof, vapor-proof, explosion-proof and underwriters' approved.

Geo. D. ROPER Corp. — Rockford, Ill.

PUMPS

ALLOYS (STEEL)—Circle 'L' casting steels for use where parts are subjected to high stresses, impacts and considerable wear; in the oil industry; and where stainless type steels of the straight chromium and chromium-nickel analyses are desired are covered in a recent bulletin of Lebanon Steel Foundry, Lebanon, Pa. Photographs and descriptions of applications and chemical and physical properties are given.

ALLOYS (STEEL)—Firth-Sterling Steel Co., McKeesport, Pa., has prepared a folder in which is given a description of the stainless steels in the higher grades manufactured by the company.

ALLOYS (STEEL)—Special alloy steels and their influence on the weight of the machine in which they are incorporated are covered in a short article entitled "How Alloy Steels Eliminate Dead Weight," published in the July issue of *Oxy-Acetylene Tips* by Linde Air Products Co., New York.

ALLOYS (STEEL)—Nickel-chromium alloys are presented completely in booklet R-33 compiled by Driver-Harris Co., Harrison, N. J. This booklet includes in addition to complete data on alloys, engineering charts, applications, and similar material. A charge of twenty-five cents is made for the book which includes considerable useful data in the form of tables of general engineering values.

BEARINGS—Application of ball bearings to variable stroke hydraulic pumps is given in specification sheet No. 203 FE of New Departure Mfg. Co., Bristol, Conn. Sheet 204 FE deals with the application of these bearings in an hydraulic feed drilling unit.

CONTROLLERS—Automatic timers, telechron motor-operated, for use on alternating current circuits are covered in catalog insert GEA-1771 issued by General Electric Co., Schenectady, N. Y.

COMPOSITION MATERIALS—Bakelite Corp., Bound Brook, N. J., has prepared a brochure entitled "The Versatile Service of Bakelite Resinold." The pamphlet sketches briefly the origin, manufacture and industrial applications of many types of Bakelite products created from the initial resinoid.

DRIVES—Splash and drip proof drives are presented in bulletin L 20584 of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The bulletin contains information on the construction of the units and applications.

DRIVES—Chain of all types and other equipment for use in the handling of materials and the positive transmission of power is illustrated and described in the souvenir book 1933, of the Link-Belt exhibit at A Century of Progress, now being distributed by Link-Belt Co., Chicago.

IRON—Nordic iron, a special grade of bar iron which is recommended by the company for service where severe vibration is encountered is described in a recent publication of Reading Iron Co., Philadelphia.

LUBRICATION AND LUBRICATING EQUIPMENT—

Constant level oilers and thermal oilers are presented in a folder prepared by Speedway Mfg. Co., Cicero, Ill.

LUBRICATION and LUBRICATING EQUIPMENT—The lubrication of small mechanical devices is discussed completely in technical bulletin No. 102.4 of Acheson Oildag Co., Port Huron, Mich. The bulletin considers each type of equipment separately and outlines lubrication procedure.

MOLYBDENUM—Properties imparted to steel by the addition of molybdenum, commercial molybdenum steels, steel castings, and molybdenum in cast iron are covered in a new booklet entitled "Mo-lyb-den-um 1933" prepared by Climax Molybdenum Co., New York.

MOTORS—Can type motors, complete wound stators with laminations exposed but turned to size, bakelite end pieces to prevent bulging, and oil resisting insulation, are described in bulletin No. F of Ohio Electric Mfg. Co., Cleveland.

MOTORS—Long hour duty, split phase motors are described in a new 6-page bulletin issued by Wagner Electric Corp., St. Louis. Descriptions of every part, its function, construction, etc., are included in addition to illustrations of the parts. The bulletin is known as part 5A of bulletin 167.

STEEL—Joseph T. Ryerson & Son Inc., Chicago, has published a larger and more complete stock list than any of its previous issues. The book includes complete information and data on practically all kinds of steel, including special grades of cold finished steels, alloy steels, stainless steels, etc., also brass, copper and other nonferrous metals.

WELDED PARTS AND EQUIPMENT—Electric Controller & Mfg. Co., Cleveland, is distributing a bulletin on its new automatic weld timer for resistance welders.

WIRE—Unusual ductility is attributed to the coating on the new Bethanized wire manufactured by Bethlehem Steel Co., Bethlehem, Pa., and covered in folder 283 of the company. This wire has a zinc coating which gives it its unique properties.

Research Publications

American Standards Year Book. A complete listing of approved American Standards and where they can be obtained, and of uncompleted standardization projects and their present status is given. The booklet also includes a description of how American standards are developed. Standards and uncompleted projects are grouped by division of engineering. Published by American Standards association, New York. 44 pp.

The Machine Tool Under Load, Deformation of a Lathe and Stresses Due to the Working Load, by Dr.-Ing. H. Kiekebusch. The cutting forces set up in turning having been determined by tests of many years' duration, the problem arises of investigating how the machine tool behaves under the action of these forces. Such an investigation forms the subject of the treatise under review. The author investigates the stresses and deformations occurring in the component parts, and the alterations in their relative positions. Published in German by VDI-Verlag G.m.b.H., Berlin, Germany, 44 pp. 5 marks.

Belden

No-Fray

Rubber Sheathed Lamp Cord

Specify Belden No-Fray for your

Lamps
Radios
Fans
Clocks
Medical Equipment
Office Equipment
Novelties
etc.-etc.

Belden No-Fray eliminates the nuisance of frayed and dirty lamp cord. Its all-rubber construction gives longer life and greater safety. It does not fray, its insulation does not break, it does not pick up dust and dirt.

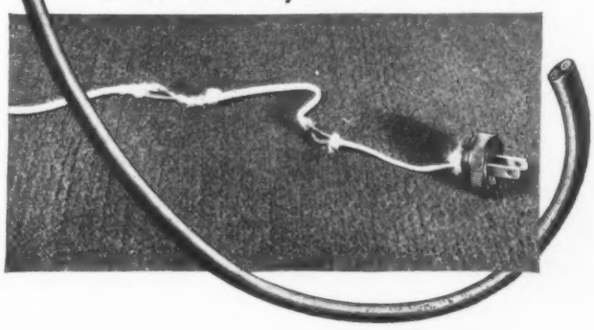
Belden No-Fray Cord is one of the first sheathed lamp cords—Type PO-SJ—to be approved by the Underwriters and to carry the Underwriters' label.

Belden No-Fray is provided in various metallic luster finishes and brown and black colors, with Belden Soft Rubber Plugs to match. Specify Belden No-Fray and increase the sales and service features of your products. Write today for sample.

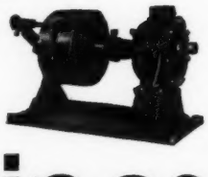
Belden Manufacturing Co.
4639 W. Van Buren St. Chicago

Belden

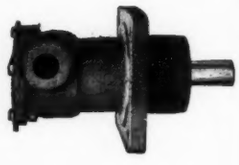
STOP this frayed cord nuisance

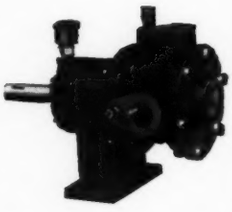


When the specifications call for pumps



Specify Vikings





Over 350,000 Viking Pumps in successful operation today . . is definite proof of their efficiency, economy and long life. Viking Rotary Pumps are adapted to the handling of all grit-free liquids . . of widely varying viscosities. The Viking Hydraulic Oil Pump is recommended for the actuation of machine tool movements and the operation of elevators and lifts and all other hydraulic oil applications. And for all cooling purposes specify the Viking Coolant Pump. All Viking Pumps employ the World Famous Viking "Two Moving Parts" Principle. Tell us what your particular pumping problem is and our staff of engineers will recommend the correct Viking to use.

VIKING PUMP COMPANY
Cedar Falls, Iowa

Books in Popular Demand

Designing for Arc Welding
Edited by A. F. Davis.....$2.50

Fractional Horsepower Motors
By A. H. Avery.....$2.25

Horizons in Design
By Norman Bel Geddes.....$4.75

Noise and Vibration Engineering
By Stephen E. Slocum.....$2.75

The Balancing of Machinery
By C. Norman Fletcher.....$2.40

The Nomogram
By H. J. Allcock and J. R. Jones....$3.00

Add 15c for postage

Available from

MACHINE DESIGN
Penton Building, Cleveland, Ohio

336-M.D.

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MACHINE DESIGN **is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.**

Business and Sales Briefs

H M. SWAIN, 52 Maypole road, Quincy, Mass., has been appointed as distributor and direct representative in the New England states for the line of standard and special washers, corner braces, corner irons and stampings manufactured by Wrought Washer Mfg. Co., Milwaukee.

* * *

Erie Bolt & Nut Co., Erie, Pa., has appointed Moorland Co., Tulsa, Okla., and Houston, Tex., its distributor in both these centers. Stocks of bolting equipment will be carried.

* * *

H. C. Thomas has been appointed sales manager for Micarta products by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

* * *

W. S. Gain, 416 Lafayette building, Buffalo, is now representative in the Buffalo district for Clark Controller Co., Cleveland, manufacturer of electrical and mechanical apparatus.

* * *

Poole Foundry & Machine Co., Woodberry, Baltimore, Md., has appointed McVoy-Hausman Co., Brown-Marx building, Birmingham, Ala., its selling representative in Alabama for flexible couplings.

* * *

John S. Andrews, for the past ten years associated with Republic Steel Corp. and its predecessors, has resigned to take charge of sales for Rotary Electric Steel Co., now completing a plant in Detroit for the production of cold finished steel bars of standard analysis by the new rotary method.

* * *

James W. Owens has been appointed by Pittsburgh Testing Laboratory as consulting engineer and director of its new welding division, the National Weld Testing Bureau. For the past three years Mr. Owens has been engaged in private consulting practice and as the director of engineering of Welding Engineering & Research Corp. Prior to this he was director of welding of Newport News Shipbuilding & Dry Dock Co.

* * *

L. W. Grothaus, who has served as general representative in charge of sales for Allis-Chalmers Mfg. Co., Milwaukee, has been appointed as assistant to the president of the company. His immediate duties will be to direct the company's interest in matters pertaining to the National Industrial Recovery Act as they relate to commercial problems. Walter Geist who succeeds Mr. Grothaus as general representative has been assistant manager of the milling department.

* * *

Edgar Stilley is now direct factory representative in the states of Maryland, North Carolina and Virginia for Chain Belt Co., Milwaukee, manufacturer of drive and conveyor chains, power transmission machinery, elevators, conveyors and complete material handling systems. Lewis E. Tracy has been appointed distributor in the Boston district for the company's line of Rex roller, block and leaf chains and cut tooth sprockets. The St. Louis office of the company has been moved to 5475 Cabanse avenue. Fred S. Bosworth is in charge.

ALLEN

TRI-MARK

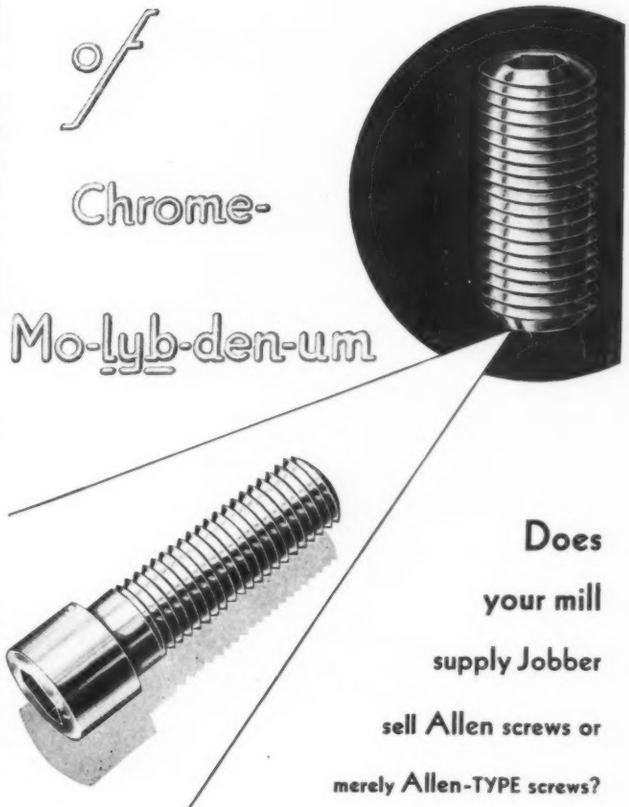
TRADE MARK

HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um



Does your mill supply Jobber sell Allen screws or merely Allen-TYPE screws?

— mark the difference!

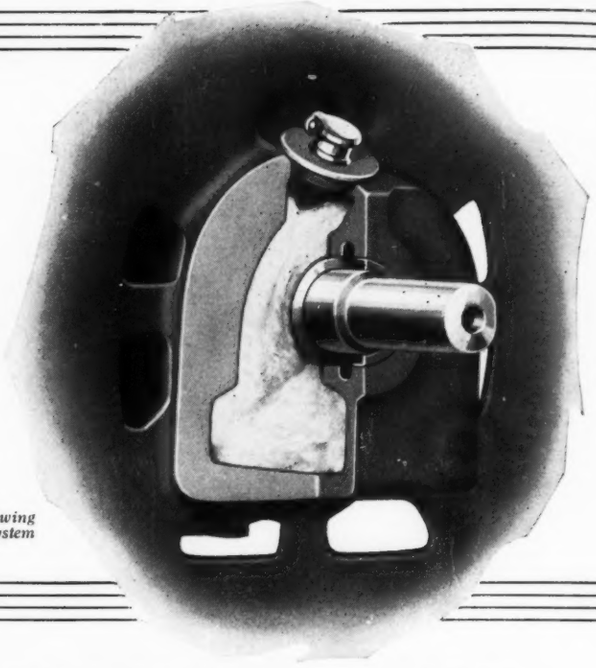
The difference is so very marked that only the NAME sells substitutes. For 23 years, hex. socket screws have been made and marketed by Allen. Commonly the name is taken to cover ALL hex. socket screws — which simplifies the sorry work of the substituter. . . To be sure your screws are Allen QUALITY as well as Allen TYPE, accept only those with the triangle (trade-mark) impressed in the bottom of the socket-hole.

THE ALLEN MFG. COMPANY

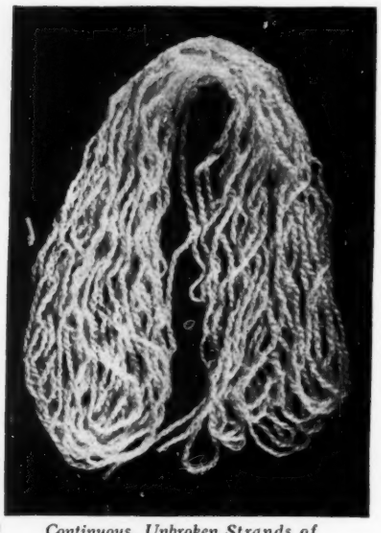
HARTFORD, CONN. U. S. A.

Century

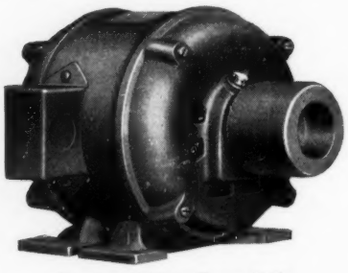
WOOL YARN SYSTEM OF LUBRICATION



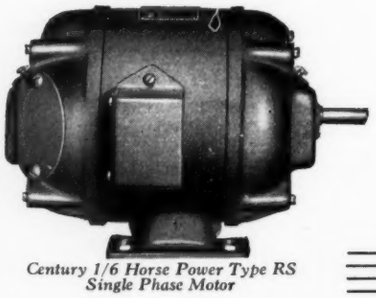
Cut-a-Way View Showing Century Wool Yarn System of Lubrication



Continuous, Unbroken Strands of Pure Wool Yarn Used in the Century Wool Yarn System of Lubrication.



Century 1/6 Horse Power Split Phase Induction Motor



Century 1/6 Horse Power Type RS Single Phase Motor

ONE YEAR'S *Continuous Operation* WITHOUT RE-OILING

Continuous, proper motor lubrication is a most important design, operating and sales factor in motor driven apparatus—particularly such frequently neglected equipment as oil burners, electric refrigerators, pumps and similar household and commercial appliances.

Century assures both manufacturer and customer satisfaction by furnishing as standard equipment on all 1 horse power and smaller motors, the Century Wool Yarn System of Lubrication—which provides one year's continuous 24 hour per day operation, without re-oiling.

This again illustrates a feature of Century's correlated design which is so desirable where motors must "Keep-a-Running" with little or no attention.

Century

MOTORS

CENTURY ELECTRIC COMPANY

1806 Pine Street , , St. Louis, Mo.

Offices and Stock Points in Principal Cities

CENTURY MOTORS ARE BUILT IN ALTERNATING AND DIRECT CURRENT, SINGLE PHASE, POLYPHASE, SPLIT PHASE, MULTISPEED AND SPECIAL MOTORS, RANGING IN SIZE—DEPENDING ON TYPE—FROM 1/250 TO 600 H. P. ALSO MOTOR GENERATOR SETS, ROTARY CONVERTERS AND FANS